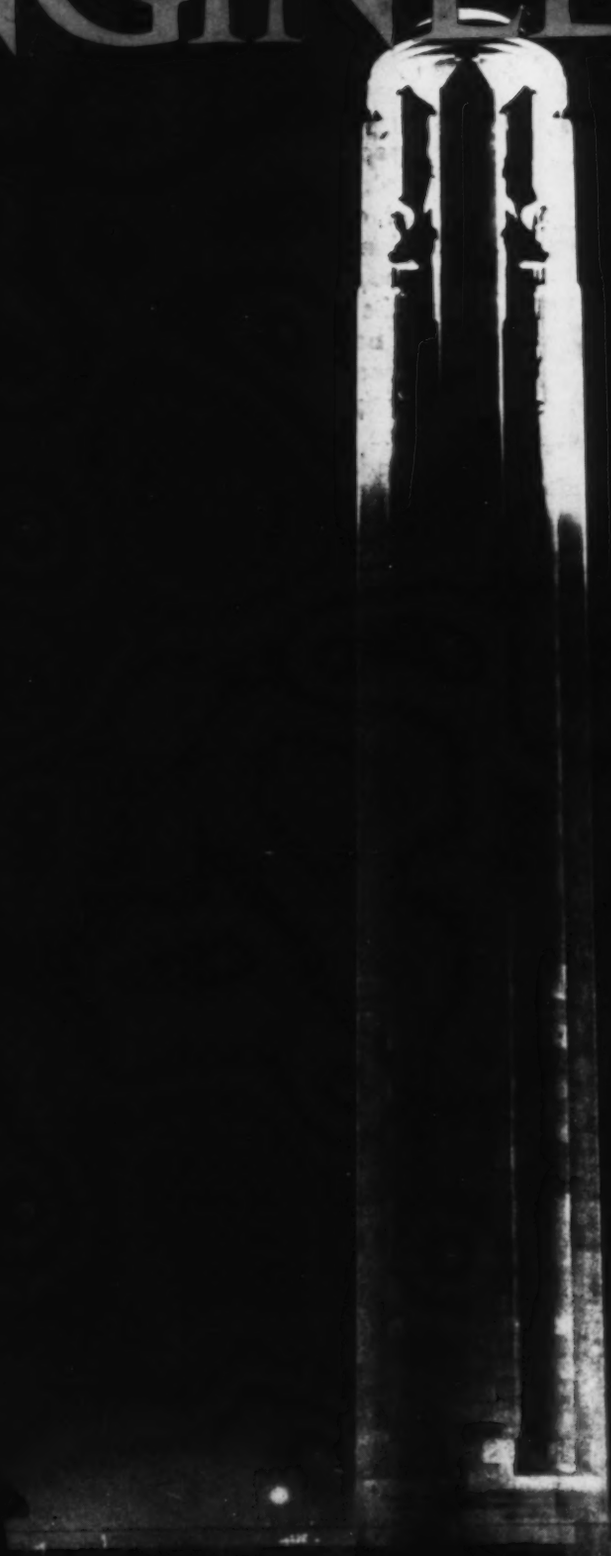
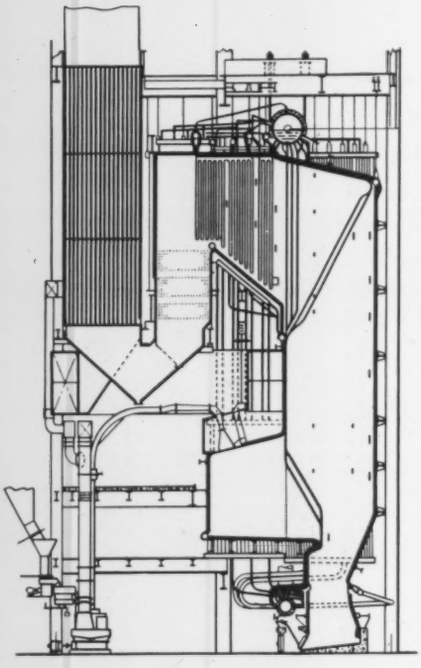
MECHANICAL ENGINEERING



May 1941

A. S. M. E. SEMI-ANNUAL MEETING—KANSAS CITY, MO.—JUNE 16—19, 1941

Duplication plus Progress

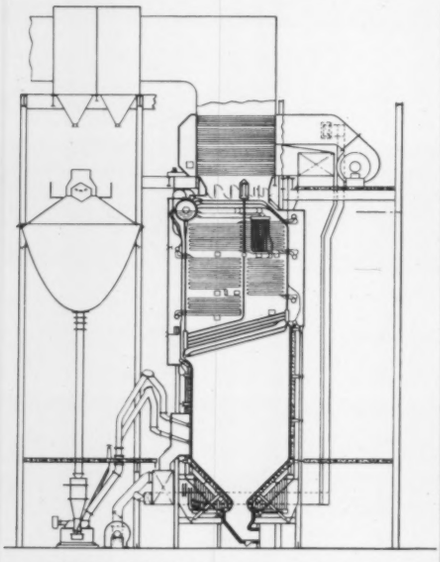


One Radiant Boiler ordered in 1938 and an additional unit ordered in 1939. Steam capacity of each unit 900,000 lb. of steam per hr. at 1500 psi.

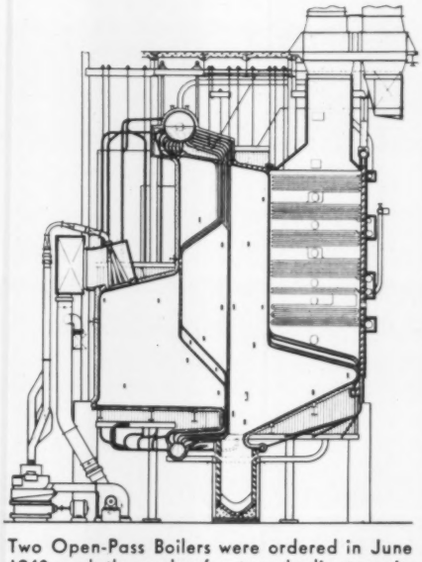
The repeat orders placed within the past few years for a total of 18 Babcock & Wilcox Open-Pass, Radiant, and High-Head Boilers are an important indication that the increase of central-station steam capacity by the installation of these duplicate units was economically sound.

These boilers are duplicates of designs that have been created within the last decade and have already proved their fundamental soundness. Thus, the purchasers of these types obtain the most modern equipment as well as the benefits accruing from the duplication of types that have proved satisfactory.

THE BABCOCK & WILCOX COMPANY
85 Liberty Street, New York, N. Y.



Four B&W High-Head Boilers having a total capacity of 1,500,000 lb. steam per hr. comprise an installation of two units made in 1937 and a duplication made in 1940.



Two Open-Pass Boilers were ordered in June 1940 and the order for two duplicate units was placed in September 1940. Each unit is to have a steam capacity of 450,000 lb. per hr. at 1500 psi.

BABCOCK & WILCOX

G-197

MECHANICAL ENGINEERING

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Courtesy The Warner & Swasey Co.

Men and Machines Against Time

(Combination end facer and turner in operation on a turret lathe. With a square cutter, this tool is a single-cutter turner. With a flat cutter it becomes an end-facing tool. The same tool, with a cutter ground to proper shape, will chamfer, face, or form the ends of bars and shafts.)

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MECHANICAL ENGINEERING

MAY
1941

GEORGE A. STETSON, *Editor*

One-Way Street

HIDDEN at the end of a long report on the 1941 A.S.M.E. Spring Meeting, to be found on pages 402–405 of this issue, is one of those dreary editorial reconstructions of an inspiring banquet address delivered by Dexter S. Kimball, past-president and honorary member A.S.M.E. Released too late for publication has come the official text of Dean Kimball's address; and anyone comparing our report and the mimeographed release will realize that what the diners heard and what the OPM released had only little in common. The release tells how the OPM handles priorities. Dean Kimball covered this portion with the deft touch of an accomplished speaker who knows how to explain things clearly and simply. But what concerned him most, and what impressed his listeners because of the sane wisdom and stimulating sincerity of his words, was what he said about the future. Here Dean Kimball ceased being a dollar-a-year cog in a vast governmental machine and became the wise humanist and student of history, one who can see clearly ahead because he can also see clearly what lies behind us. And the vision is a sobering one.

War, as Dean Kimball said, is a one-way street. It makes no difference what we call it, whether we fight it in the machine shop or on the field, or what the motives and objectives are, or even what the outcome is. There is no turning back. We never find ourselves back in the familiar surroundings from which the street led. Things are new and different.

In his skillfully written autobiography "Pilgrim's Way," Lord Tweedsmuir mentions the British soldiers returning from Flanders and the Dardanelles to resume life on the fields their fathers and grandsires had tilled. Their way of life had been resumed by those who came back in much the same way as it had gone along before the interruption. But it was not the same; only the appearance was the same—the fields, the buildings, the lanes and rivers, sunset and sunrise, the cycle of seasons, and the succession of family and neighborly experiences. A little bit of Scotland, a stretch of moor or woodland, a valley, or a portion of sea coast—these remained; but the atmosphere of the world itself was changed. Whether they realized it or not these men had been traveling on a one-way street and only the appearance of the landscape was the same as it had been when they had left it. Other men there were who knew this. Lord Tweedsmuir was one; and in another chapter he tells of his concern for the British Empire. Training and opportunity had placed him in a position where he could ponder thoughtfully about the responsibilities of England. The effect of those responsibilities reached back to the quiet upper valley of the Tweed and every spot on the British Isles. The one-way street might lead into familiar and peaceful intervales; into towns bustling with postwar reconstruction; to seaports busy with the world's commerce; to better sanitation and a lower death rate; to modern factories; to an electrical grid, the motorcar, the cinema, the broadcast, trade unions, unemployment insurance, and old-age pensions; but it did not end there, as Tweedsmuir and others foresaw.

And so it will be with us. Speaking just before Dean Kimball, President Hanley pointed out some of the immediate effects—a Selective Service Act, high taxes, longer hours and shorter vacations, an opportunity to choose between national unity for the preservation of the American way of life, and moral, political, and social decay.

Where does the one-way street lead? As Dean Kimball said, we shall emerge into the era of postwar reconstruction with the most powerful and costly navy the world has ever seen. Our financial and moral burdens will be crushingly heavy. Our world will be smaller, our interests more closely than ever before tied up with those of the rest of the world, our problems more complicated, our economic competition more keen. Already we have pushed our outer defenses deep into the Atlantic and the Caribbean. Where will our outposts be? And what will be the limits and policies of our stewardship? It was to this question that Dean Kimball invited attention.

Where shall we find the men to administer the stewardship? It has been said that modern war is an engineer's war. On mechanization and the machine shop is based the power of modern arms. Are not peace and order also so based in a modern world? Will not the problems of reconstruction and of the extension of the American way of life have to be solved largely in the engineer's manner? Will engineers be big enough for the job? Engineering is only a portion of what is needed. There must be understanding, wise leadership, skillful administration of public and private office, and unity of action and in ultimate objectives, tempered with patience, intelligence, and humility. It is a job for all our people with heavy responsibilities placed on the shoulders of engineers.

A Timely Bibliography

SEVERAL pages of this issue are devoted to a bibliography of articles that have appeared in MECHANICAL ENGINEERING, the *Journal of Applied Mechanics*, and A.S.M.E. Transactions, during the last five years on

subjects that are important to designers, shop men, and administrators of business enterprises engaged in national-defense projects. The bibliography was prepared to afford a convenient finding list of papers that may have escaped the notice of readers or have been forgotten by them because of interest in other subjects at the time of publication. Subjects in the field of power and power plants have not been included.

Anyone glancing over the bibliography will be impressed with the wealth of material, particularly in the field of advanced design, that the Society's publications contain. The considerable number of references to the *Journal of Applied Mechanics* indicate that the Applied Mechanics Division has been active on the frontiers of expanding knowledge. In only a very few cases has the subject matter of these papers been treated before. Although some of the material has been incorporated in recent textbooks and handbooks, it is, for the most part, unavailable except in the form in which it was originally published.

Present and future conditions place a high value on the type of material represented in the bibliography. Although the nation needs an enormous quantity of goods and designs that can be produced by routine methods, it faces an increasing need for the new and the refined design or product that marks a real advantage in economic or in military competition. The entire world is more actively engaged at the present time than ever before in competition in these fields, and with the return of peace, economic competition will be even keener. What was a nine days' wonder a few years ago will be hopelessly outmoded a few years hence. A margin of a few miles per hour in speed on the sea or in the air, an advantage of a few pounds less weight, or of a shorter production time, or a longer life, or a more reliable product may turn the scales of victory one way or another, and may be the difference between economic leadership and a second- or third-rate position. Design, as well as transportation, has its horse and buggy era.

There are numerous agencies through which the beginner can acquire the rudiments of design. They serve a necessary and useful purpose in the early stages of the education of the mechanic or the high-school graduate who enters the drafting room. But the engineering society is the agency through which the expanding technique of design is made public. As one of these agencies the A.S.M.E., and particularly its Applied Mechanics Division, holds an important post. This fact the bibliography proves. Extension of this field is a prime responsibility that the Society cannot abdicate without losing its leadership.

Use the Best You Have

IN presenting his paper "Improvised Methods for Rapid Munitions Manufacture," printed in this issue, George T. Trundle, Jr., told the story of the farm hand who called out for a man who could milk a cow because the electric milking machine had ceased to function. The story illustrates our essential helplessness when the labor-saving gadgets of modern civilization get out of order, and demonstrates an attitude of mind, easy to fall into, that we must do the job in the most approved manner or leave it undone. But the time comes, as it did for the farm hand, when we have to fall back on the next best thing because we can't get the best. A shortage of aluminum is teaching designers to turn to other materials, even though it was not many years ago that aluminum was too costly to use for any common article. A recently built warehouse, estimated probable life not more than five years, called for steel construction, but a bright engineer whose father had probably seen only a very few steel buildings, substituted wood, thereby saving half the cost and conserving structural steel for jobs where wood could not be used. And so Mr. Trundle, whose experience antedates the years when we began to think that all mass production had to be done on specially designed tools, cites numerous examples of cases where the scrap heap, or the second-hand shop, or the idle drill press, has been resorted to when the jam in machine-tool production has delayed delivery of the machine the manufacturer hoped to use in a national-defense order. Call it improvisation, or ingenuity, or just horse sense as you will, the lesson is there for all to learn, and when time is the most vital element in a program, as it is today, emphasis on expedients cannot be too vigorously made.

A corollary to improvisation is farming out, or subcontracting. Under the spur of rapid expansion, time and forethought commend the utilization of productive capacity in small shops equipped to handle special jobs. Readers will recall the excellent example described by P. R. Bassett of the Sperry Gyroscope Company, printed in these pages in February, of "production orders" farmed out in anticipation of sudden increase in the demand for instruments.

Another interesting example was given by Arvid Nelson, of the Hamilton-Standard Propellers, in a paper read at A.S.M.E. Third National Defense meeting, Cleveland, March 12 and 13. In this case the farming out was not resorted to solely to increase production rapidly. There were collateral advantages in avoiding what might sometime be unneeded plant capacity, and the shift of workers from towns where they had homes and an employer to one being subjected to the mushroom growth of a wartime boom.

Commonplace and obvious as improvisation and farming out appear to be on the surface, the seriousness of our national emergency justifies reference to them. In addition to frequent notice and example that have appeared in these pages, and the similar attention directed by other publishers in this field, the Office of Production Management, Labor Division, has issued a series of pamphlets on "Farming Out Methods." Under the subject of subcontracting, the matter was discussed at the A.S.M.E. National-Defense meeting in Cleveland in March, and at the meeting, under the auspices of the A.S.M.E. Management Division and others, at Philadelphia late in April. It all boils down to intelligence and ingenuity, with the common-sense moral: Use the best you have.

The FUNCTIONS *of the* DESIGN ENGINEER

By W. E. JOHNSON

GENERAL ELECTRIC COMPANY, LYNN, MASS.

MANY times during the last several years, I have mused on the functions performed by design engineers, and have wondered whether these could not be classified in a way that would bring about a clearer realization of the various types of ability required. Such a classification might also assist in bringing to pass some improvement in the methods of education. Undoubtedly my thoughts on the subject have been colored by those of numerous other writers. So it is with a due sense of acknowledgment to these prior authors that I submit my own thoughts on the matter.

Before the subject can be intelligently discussed, it is necessary that we have a common understanding of the designation "design engineer." The term is used variously in different organizations but, in this paper, it will be used to denote an engineer who is responsible for the complete development of a product from its inception to its production. This definition will exclude, generally, responsibility for the operation of a department.

As we all know, not all of the desired attributes are ever found perfected in one man. Nevertheless, it is instructive to assume that we have the ideal man for the job, and to determine what diverse abilities he must possess. On this basis, I shall endeavor to list and discuss some of his principal functions and attributes.

THE ACQUISITION AND RETENTION OF KNOWLEDGE

It has been stated (rather loosely, I think) that the primary purpose of the college is to teach the student to think. There is no doubt that this is one of the main purposes, but it seems very evident to me, at least, that the college must also impart a great deal of useful knowledge to the student and teach him how to use the knowledge of others. One can appreciate this by considering the absurd extreme of having the students imitate the early philosophers, who ignored the ascertained facts relating to the nature of the universe in favor of abstract reasoning. Upon graduation, such students would know as little of the true nature of things as did the old philosophers, and they would scarcely be capable of performing any practical function in our modern world. The scientific method, as a matter of fact, is based on knowledge obtained by observing the nature of things as they are, and reasoning to draw deductions from these known observed facts. In other words, knowledge comes first—reasoning second.

It is important, I think, to realize that the amount of knowledge, as compared to the amount of deduction that is necessary, varies in the different professions. In chemistry, for example, a very extensive knowledge is required. In engineering, the fundamentals one must know are relatively few. For example, the simple concept of proportionality between stress and strain, together with a knowledge of Poisson's ratio, forms the entire basis of the theory of elasticity. In spite of the elementary nature of the fundamental knowledge, however, it requires years to attain proficiency in the use of the theory. Newton's three laws of motion still determine the movements of practically all the celestial bodies, but it takes a long time for a student of astronomy to attain the necessary proficiency in dynamics.

It is probably this type of knowledge that teachers have in mind when they emphasize thinking ability rather than knowledge as a desired attainment. However, the fact is that engineers do not go back to fundamentals in all of their problems, any more than the mathematician goes back to geometry as a starting point when he has a problem in the calculus of variations. The designer, who is studying the vibration of a turbine wheel, will not go back to the fundamentals of elasticity and dynamics, but will study textbooks or papers dealing with this special problem. Rather than use the fundamentals of thermodynamics to derive the thermal properties of steam, we use steam tables. And our handbooks are always ready with beam formulas, gas-flow relations, mathematical tables, and the like. This all means that the designer, if he is to use the accumulated information available to him efficiently, must have, in addition to his knowledge of fundamentals, some knowledge of the methods and work of others. He must know that the information exists, know where to look for it, and be able to use it. This is not knowledge of a fundamental sort, but it is important and, obviously, is very much more extensive than the knowledge of fundamentals. It is the type of knowledge which makes us aware of what others have done—aware of their discoveries and methods. Without it our progress would be very slow.

In addition to this extensive knowledge in his own field, the designer must accumulate, both in school and in practice, a wide knowledge of the arts and sciences which contribute to his own field.

Knowledge, then, must be considered a very important part of the designer's equipment. It has been considered here in three parts, namely, the fundamentals or natural laws, the methods and findings of other workers in one's own field, and the contributions of workers in allied fields. It is well known, of course, that the bulk of a man's knowledge, particularly in the last two categories, is acquired after graduation when he has specialized in some one branch of industry. The problem of deciding how far college training should go in imparting knowledge to the student is an important one.

CREATIVE THINKING

Problems do not come to the designer all "wrapped up" in a set of circumscribed conditions which permit of only one solution. His most common problem, very likely, is to lower the cost, or to better the performance, of some machine or engine that is already in production. In its mild stages, this problem may require only a few minor design changes. In a more vigorous attempt, however, it will involve sweeping substitutions of entire designs.

Less frequently, the designer is called upon to create some entirely new machines, perhaps larger, faster, or more economi-

Contributed by the Committee on Education and Training for presentation at the Semi-Annual Meeting, Kansas City, Mo., June 16–19, 1941, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

cal than preceding designs, but still bearing the characteristics of his main line of units.

Even less frequently is he called upon to create a design that is entirely new in its function. When such a device is required, it may be (and most often is) an accessory of a larger machine. On rare occasions of course some completely new device is invented by a designer, but inventions of this sort occur infrequently.

Despite the rarity of inventions (such as the radio), the designer is constantly taxing his ability to create new designs, new arrangements, and new ways of doing things. Nor are the small inventions unimportant. It often happens that the entire success of a given type of engine, compressor, or the like, may hinge upon finding an "accessory" which will perform some function satisfactorily. For example, the success of the in-line type of aircraft engine may hinge upon developing an adequate cooling system; the success of a turbine-driven locomotive may depend entirely upon the condenser design and there are similar cases ad infinitum. As the design of a complete machine progresses, the critical points in the design are disclosed and, on these, the designer must exercise all his ingenuity and inventive ability if he wishes success.

Set apart from the field of pure invention, but closely allied with it and in reality an adjunct to it, is the art of arrangement. It is this art which decides for us whether an 8-cylinder engine should have its cylinders in line, in a V, or in a radial arrangement; whether a transmission housing should be part of the crankcase or separate; whether a compressor should have a vertical or horizontal crankshaft; and so on. It is aptitude in this art which makes the creations of a good designer appear well knit and coordinated, where the novice will invariably finish with a "Christmas tree," whose ornaments dangle from here and yon in an incoherent, multitudinous array. Obviously, the functional utility of a design and its cost are both closely related to the arrangement of its component parts. In any product we build, there are dozens of ways in which the component parts may be arranged and yet permit the performance of its primary function. The best artist is he who first arrives at the arrangement which gives the greatest utility with the best appearance and the lowest cost.

It is almost self-evident, then, that the designer must use creative thinking in his work. The term "creative thinking" does, I think, describe this thought process more accurately than the term "inventive ability," for the latter, by its connotation, is restricted to the creation of new devices and tends to disregard the important art of arrangement.

VISUALIZATION

A propensity for creative thinking is so closely allied with ability to visualize the nonexistent that the two are well-nigh inseparable. This knack of imagery usually manifests itself as the ability to reduce ideas to sketches and working drawings which will clearly convey ideas to others.

That some boundary exists between this ability and the ability to create is probably true, for certainly there are numerous draftsmen who are good at visualization without having any marked creative ability.

Whether its connection to creative ability is close or remote, however, the ability to visualize is of tremendous assistance to the designer. It provides the window through which he may see and analyze his ideas.

PROGNOSTIC ABILITY

"Prognostication" is an unusual word. Probably any self-respecting engineer would eschew it in the first place, and would be suspicious of insult in the second place if one called him "a prognosticator." Nevertheless, prognostication is the function performed by a designer when he scrutinizes his design for the purpose of foretelling its operating characteristics. I am not thinking now of analysis of the performance, stress, or other criteria, but of the thought process which may be described as "trouble shooting in advance." It is the type of thinking and visualization which makes the designer aware of the critical points in his design.

This ability should not be confused with analytical ability. A man may have great analytical ability, but it is useless from the designer's standpoint unless he knows what to analyze. The histories of various developments are usually replete with examples of problems in design that were simply overlooked by designers. Sometimes these oversights cause serious trouble with the first units produced from a design. At other times, some important idea, which may permit an improvement in design, is overlooked and the advantage is lost to a competitor.

The attitude of mind necessary for prognosis is difficult to acquire. Essentially, it requires the designer to search critically for weak points in his design, keeping in mind all conceivable operating conditions. In the optimistic frame of mind which accompanies the first realization of a "solution" to some design problem, this is not easy. The designer is too happy and relieved at finding something "that will work" to turn around and attempt to find some conditions under which "it will not work."

So important is this search for weakness in a design, however, that it is nearly always advisable to pass any design through the hands of other engineers for either analysis or test. This other group, having no paternal interest in the design, has a more critical and unsparing attitude, and is much more apt to discover the weak points in advance of the production stage. In doing this, of course, one must be careful not to "kill" a promising design. "The father should always have the right to rescue his child."

We have not far to look for examples of the consequences when design problems are overlooked. Certain car models will suddenly become notorious for having trouble with a clutch, water pump, carburetor, or some other part. Scarcely ever are these troubles caused by any lack of men with analytical or testing ability. They are almost invariably the results of oversights—the lack of a realization on the designer's part that the problem existed. The penalty is high, imposing direct financial loss and loss of reputation on the manufacturer.

It is well for the designer to realize then, that, while analytical ability is important, it is probably more important that he clearly apprehend the problems which exist, and that he be able to formulate them. The designer must put his problems "on the platter" himself.

ANALYTICAL ABILITY

When we discuss analytical ability, we usually think of it in relation to mathematical analysis. But the ability to analyze a problem does not necessarily imply the ability for mathematical analysis. Analytical ability is an attribute of the individual, and resides in him whether he uses mathematics or not. Mathematical analysis is one of his tools, just as chemical analysis, spectrum analysis, photoelastic analysis, or dimensional analysis may be.

There are many individuals with very little or, at most, an elementary knowledge of mathematics, who nevertheless are keen analysts. It is certainly true, in engineering, that such individuals would find a wider scope for their abilities were they familiar with advanced mathematics. A good mechanic is a good mechanic whether he has elaborate tools or not, but he can do better work and extend the scope of his ability if he is well equipped with tools. Steinmetz would undoubtedly have been a brilliant man whether he knew mathematics or

not, but one can scarcely imagine his making such valuable contributions to electrical engineering without a thorough knowledge of mathematics.

Then too, there is this to be said for mathematics that, of all formal studies, it is the one which most effectively trains the mind for analysis. For this reason, and also because it is a valuable tool, mathematical ability and analytical ability are often found together in the same individual.

Of all the characteristics an individual may possess, the ability to analyze is one of the easiest to develop by training, provided the aptitude is present. This is important in its influence on education, for the major part of the work done in an engineering college seems to have as its purpose either a growth of knowledge or a training of the students' analytical ability. I venture the suggestion that such educational efforts are much too narrow in scope.

DIAGNOSTIC ABILITY

We are accustomed to think of diagnosis as one of the functions of a physician, and we certainly appreciate the importance of this faculty in the medical field. Moreover, we recognize a wide difference in the abilities of physicians as diagnosticians.

Probably not so well recognized is the fact that designers need to develop and use this same ability in a high degree. We do it, but do not often think of it as diagnosis, being wont to call it (in typical engineering vernacular) "trouble shooting," or "taking the bugs out." The need for the exercise of this ability usually arises in that stage of a development where a sample or first operating machine of a new design has been built and is under test. In this stage, unforeseen troubles of one sort or another usually develop, and the need for accurate and skillful diagnosis is urgent, the success or failure of the design often depending upon the result.

Drawing the parallel between the functions of the physician and the designer still further, we can see that, where the one has his cardiograph, the other has his indicators and oscillographs; where the one has his blood tests and urinalysis, the other has his chemical tests; where the one has his basal-metabolism test, the other has his heat balance; and so on. In other words, there are, in either case, elaborate technical facilities with surprisingly parallel functions to aid the diagnostician. But these are only the tools, and the mere possession of them does not make either a physician or an engineer a good diagnostician. There is some innate ability, difficult to define, which makes one man better than another at diagnosis. Just as some automobile mechanics and some designers have a natural bent for "trouble shooting," so have some physicians a natural bent for diagnosis. As with many other aptitudes, experience is needed to develop this knack fully, but it appears certain that experience alone is insufficient—that the innate ability must first be there.

Ordinarily, I think engineers must concede that the physician has the more difficult task, for he cannot take his patient apart under ordinary circumstances, nor can he change the "design" of his patient by an operation and later put him back as he was to prove his point. On the other hand, the engineer's task has its own peculiar difficulties and liabilities. The designer often has six or more cylinders to study simultaneously in place of one heart, and his patient, being dumb, forces him to observe all symptoms objectively, whereas the physician can at least be told where the pain is located.

The liabilities are somewhat different, too. A mistaken diagnosis by a physician may place upon him the serious responsibility for a human life, but ordinarily he will only lose one patient for one mistake. A similar mistake by a designer may give him several thousand sick machines, each of them with a direct financial liability, even to the inclusion of burial expenses.

Diagnosis is perhaps the most important on machines which are produced in large quantities, such as automobiles, household refrigerators, garbage-disposal units, vacuum sweepers, washing machines, and similar products. These have in common a low-priced, large-quantity market in which first cost to the customer is of prime importance if production is to be maintained at a profitable level. With such high production quantities, the manufacturer can afford to build and test exhaustively numerous samples. Consequently, the designer may profitably experiment with various simple ways of doing things, the performance of which is almost impossible to calculate. For instance, a splash lubrication system may be less expensive to manufacture than one using forced feed. However, it is practically impossible to compute the rate of oil flow to a bearing that is fed by splash. It requires painstaking experimentation to find out whether the splash system is adequate under various conditions, and to determine just how sensitive the system is to such variations. Now, if only one, or a very few machines were to be produced, the designer would certainly be inclined to use an oil pump which could be depended upon to deliver oil at a definite pressure to each bearing, for he could not afford the experimental work necessary for developing a satisfactory splash system.

Because of the all-important requirement of low cost and ingenious design in high-production articles, it is common to find men in charge of their development who have only a mediocre technical or analytical training, but who are excellent experimenters, and are particularly strong in creative thinking, visualization, prognosis, and diagnosis. For prior knowledge they have little need, since knowledge comes to them from the job, and analysis other than the most elementary is at most a desirable accessory.

Diagnosis, then, is a very important attribute. It is the ability of a man selectively to observe certain signs or symptoms which characterize the operation of a machine and, by a mental process that is both intuitive and logical, to determine the causes of the symptoms. It requires perspicacity in a high degree.

ON THE ART OF COMMUNICATING IDEAS

The art of communication is as old as civilization, and proficiency in it has characterized the attainments of nearly all public leaders throughout the ages. It is of the greatest importance to all men, and its importance increases with man's responsibility.

There are various techniques and sciences associated with communication, but it in itself is an art, and should be cultivated as such. The composer of music must have command of the technique of composing, writing, and transposing music, and the painter must know the technique of handling a brush and of mixing his paints. But composition of music and painting are both arts. Similarly, the engineer requires a mastery of the technique of grammar, drawing, and chart-making, since these are tools he must use in his communications; but he should realize that all these are merely technical aids to the general art of communication.

The designer, in his communications, seeks to transmit to others an idea, a deduction, a method of procedure, a geometrical description of an object, and to set forth specifications of materials and processes. In doing any of these things, he may transmit his thoughts orally or in writing, and by means of drawings, charts, tabulations, and even mathematical formulas.

The designer himself is usually responsible to a managing engineer to whom he must impart many of his thoughts. Be-

fore the designer can obtain the necessary funds for a development program he must convince his superior that such a program warrants the expenditure of the sums involved. In doing this, perspicuity is of prime importance. Whether he writes or talks, it is necessary that his proposition be presented so clearly that the desirability of it becomes readily apparent to the superior. This often places on the designer the difficult task of explaining some highly technical development in terms that a layman can understand.

It is true that an executive will occasionally take for granted the desirability of some technical project that he does not fully understand if it is proposed by a designer with an established reputation, but even this is the exception rather than the rule, for any man is distrustful of something he does not comprehend. The young designer, then, has little chance of success in an individual enterprise unless he can present his case with clarity and brevity. Hence, the importance of developing the ability to express himself.

If the designer is to be at his best, he too needs to appreciate the broad scope of the art of communication and needs to develop himself in all of its forms of expression. Moreover, the development should be done as a whole, and not in the usual disconnected fashion.

ADMINISTRATIVE ABILITY AND PERSONALITY

The designer need not be possessed of the business acumen and broad executive ability necessary to the managing engineer, but he should be reasonably proficient in the ordinary administrative duties that go with his job. Even though he may not be the head of his design department or section, he still must oversee the work of a few other individuals, perhaps mechanics, testmen or draftsmen, and he will be required to organize and execute his own projects.

His duties will require a reasonable amount of paper work. He must also learn to direct the activities of others in a manner which will obtain their cooperation and respect. He naturally will profit if he can do his paper work in an efficient orderly manner and an agreeable personality is an asset to anyone, whatever his field of endeavor.

It is a fact that some "grumpy" designers are tolerated and even pampered by their superiors because of their technical skill, but it should be remembered that the "grumpiness" usually develops after the designer has made his reputation and feels secure enough to air his grouches publicly. So it is very unwise for a young man with no reputation to emulate such conduct. It is well to remember, too, that for every cantankerous individual who is tolerated, there are probably two or three discharged of whom we hear nothing. They are the men who "just couldn't get along." Besides, there is some pleasure as well as profit in making life more agreeable for one's associates. In every conceivable way, a pleasant personality is to be desired.

There is, however, a tendency to stress the importance of a good personality to the point of producing affable ineffectuality, and this, too, is a serious mistake. No man can go very far in life unless he can, at the proper moment, stand on his feet and give battle. It may be only a verbal encounter but it nevertheless requires courage and a fighting instinct. To do battle successfully, of course, it must be done at the right moment, and above all, one must be right and be able to prove it—particularly in a first engagement. The insipid individual who agrees with everyone cannot be trusted with any big job.

While the administrative duties of the designer are usually not in the same class with those of the executive, the majority of designers are nonetheless interested in developing their executive abilities, for it is often a design engineer, or at least an engineer with experience in a design department, who becomes the executive head of such a department. Naturally, the young designer has a period of several years available to him in which he can develop, and to a limited extent demonstrate, his executive ability. So there is no urgent need for him to study the technique of management during his school years. In fact, such studies may be a liability to the extent that they dwarf the development of those aptitudes which he urgently needs soon after graduation. However, there is no doubt that a college training should include a few well-chosen and coordinated courses which will lay a foundation for the student's later career.

OTHER PERSONAL TRAITS

The successful individual in any field of endeavor must be endowed with certain well-defined personal qualities, such as integrity of character, fidelity, courage, and pertinacity. It is not proposed to discuss these here, since the purpose is to discuss those attributes which are required of the designer as apart from other individuals. They are mentioned merely to emphasize the point that professional ability is not everything, that the more nebulous attributes of character must also have a place in the designer's life.

CONCLUSION

The chief attributes or functions required of the designer have been discussed. Summarizing, they are:

The acquisition of useful knowledge.
The ability to think creatively.
The ability to visualize.
An aptitude for prognosis.
Analytical ability.
Diagnostic ability.
The ability to communicate clearly.
Administrative ability.
Sound personal character.

Most industrialists will agree that really good design engineers are scarce. The reason for any scarcity is probably not to be found entirely in lack of training, but very largely in a natural scarcity of men whose aptitudes cover the desired range. On the other hand, suitable training is certainly not to be neglected, and is one of the most difficult training problems facing both the colleges and industry.

One would be optimistic indeed to expect all of these traits in proper balance in one individual. The fact that they are not so found is one reason for the importance of cooperative effort and for the consequent importance which must be attached to personality.

One is always tempted to place a list of abilities, such as that given, in their order of importance. Frankly, I do not think any such order can be assigned. Nor do I think it would be useful if assigned, for we must take men as they are and, while we hope for a balanced individual, all we can do practically is to approach a well-balanced group by a wise selection of the individuals, so that each will properly complement the others.

There is, however, one attribute which may well be placed before all others, and that is personality. No one quality can do more to assure a man of success, nor, by its adversity, do more to bring him failure and unhappiness. I realize that "personality" is an all-inclusive word, taking within its scope the mentality of the individual. But we can surely think of personality as something which, though integrating all qualities, may nevertheless be apprehended as something apart, something which emanates from within a man and, transcending all definite traits, yet defines him.

CREEP *of* NEOPRENE *in* SHEAR

A Progress Report Based on Laboratory Tests

By F. L. YERZLEY

ORGANIC CHEMICALS DEPARTMENT, RUBBER CHEMICALS DIVISION,
E. I. DU PONT DE NEMOURS & COMPANY, INC., WILMINGTON, DEL.

IN AN earlier paper[1] certain characteristics of neoprene relating to the design and performance of neoprene springs were described. That paper was intended to present the results of laboratory experiment in such a way that possible applications could be worked through the preliminary planning stage based upon selected properties prior to actual consideration of final details. In much the same way the present paper is intended to present some preliminary information on the creep of neoprene in shear. The data included were obtained entirely from tests of laboratory samples, rather than commercial products, in a survey now in progress to classify different candidate compositions for spring service. The present paper is, therefore, quite limited in scope, and is offered only as a preliminary progress report. It may, however, serve a useful purpose in illustrating the manner in which compositions can be developed by physical tests prior to actual incorporation in a specific design. In particular the data support the conclusion that regardless of the general method used to obtain different characteristics, each of the essential properties—modulus, resilience, and any others that may enter into service—must be independently evaluated. In a broader sense the content of this paper may be considered to apply to other rubber-like materials, neoprene being taken in this case only as a convenient example.

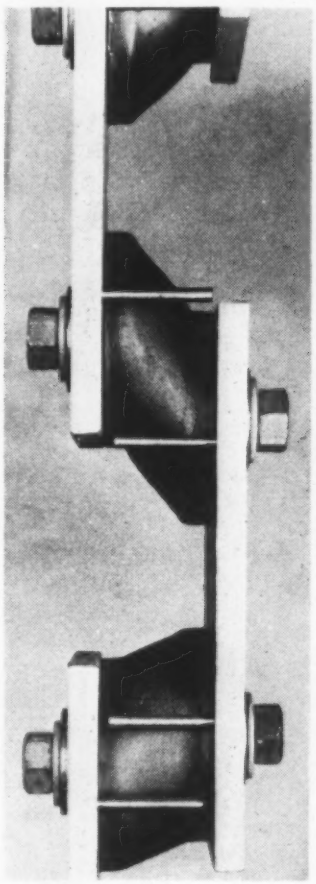

FIG. 1 TYPICAL TEST SPECIMENS UNDER LOAD

All tests described in this paper were conducted at a constant temperature of 82 F ± 2 F under a static load of 47.7 psi.[2] The test specimens were cylinders 1/2 in. thick and 2 in. diam vulcanized between and adhered to metal plates 2 in. diam and 1/4 in. thick. Five samples of this type were mounted in series to support the same static load in the manner shown by Fig. 1. The metal plates used to tie the successive samples in a series were equipped with pins mounted in front of the samples. Punch marks on these pins served as bench marks from which the deflection of the samples was measured using the cathetometer arrangement shown in Fig. 2. By this method deflections can be measured to the nearest ten thousandth of an inch. In most cases the accuracy is justified by the uniformity of the results obtained. In other cases discrepancies far greater than the precision of linear measurement were shown. In addition to the evaluation of creep, the moduli of the stocks in compression and the resilience were measured on the Yerzley oscillograph. Special test specimens for the measurements on the oscillograph were cured from the same mixes used in the preparation of the drift specimens. Hence this paper will present information on shear with related measurements of other properties to more completely identify the mechanical characteristics of the compounds.

In order to reduce the data for the several compositions to comparable conditions the practice has been sponsored of expressing creep as a relative figure compared to the initial deformation. Thus, relative creep, referred to in this paper, is creep expressed as percentage of the initial deformation. This is a logical method of comparing data if we assume that in the range of deformations dealt with creep for a given sample is proportional to the initial shear deformation under load. Hence, for the purposes of this paper, this assumption will be made although it is apparent that verification of this point is highly desirable and will be necessary before refinement of this method of expressing shear creep can be accomplished.

Inasmuch as five specimens were mounted in series in each group on test it is apparent that simultaneous readings could not be taken on all samples at the start of the test. Consequently, it was necessary to establish some arbitrary time limit for the first readings in order to obtain an approximate value for the initial deflection.

The practice followed in obtaining the data for this paper was to start with the top sample in a group of five, 5 min after the application of load. By this procedure data were obtained on all samples within the time interval between the fifth and eighth minute after loading. Within this rather small time interval the effect of creep upon the measured magnitude of the deflection is considered to be of secondary importance. This is true only because the interval within which the measurements were taken was small. It is characteristic of rubber-like materials, however, to show the most rapid rate of creep immediately following the application of load. It was, therefore, considered desirable to make the reference point for the measurement of creep the value of the deflection at some considerably later time.

[1] "Neoprene as a Spring Material," by F. L. Yerzley, Trans. A.S.M.E., vol. 62, July, 1940, p. 469.

[2] The actual load on the lowest sandwich of each group is 47.7 psi. The accumulated weight of the series, however, makes the load on the top sandwich 2.4 psi or 5 per cent greater. Relative creep figures are automatically compensated in their calculation for this variation in load, but the per cent shear data in Tables 1 and 2 are slightly in error.

Contributed by the Rubber and Plastics Subdivision of the Process Industries Division and presented at the Annual Meeting, New York, N. Y., Dec. 2-6, 1940, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

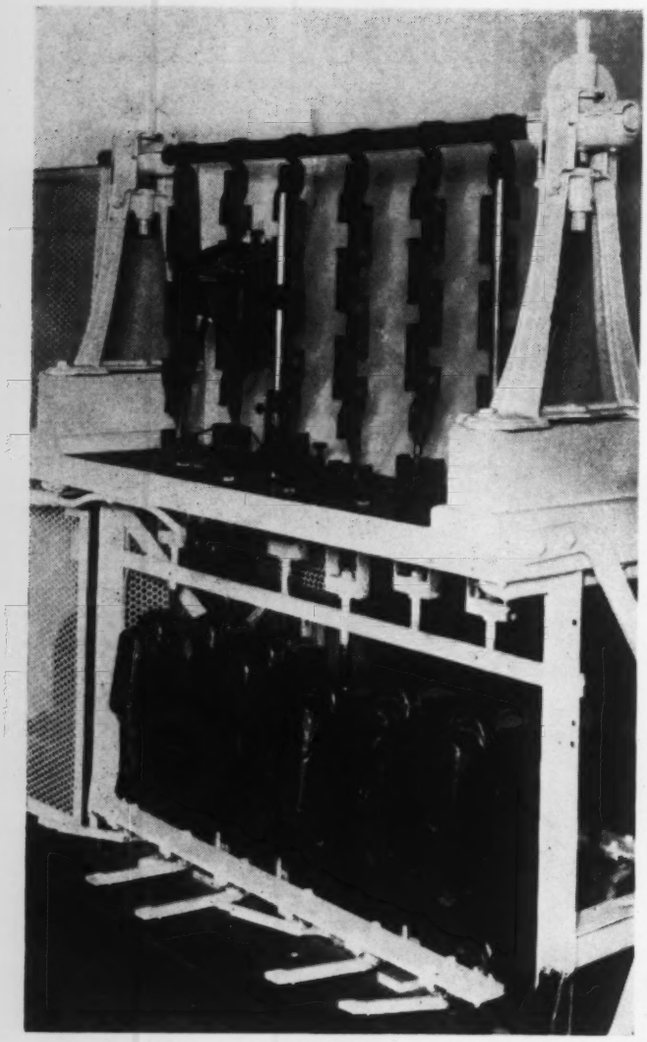

FIG. 2 THE ASSEMBLED APPARATUS SHOWING THIRTY SPECIMENS UNDER LOAD

For this purpose the two-hour readings were selected and the relative creep figures given in the paper represent creep beyond that which occurred up to two hours. In other words, the relative creep at two hours in all cases would be zero.

Two general methods of varying the physical characteristics of neoprene vulcanizates have been used in the preparation of the specimens for these tests. The first general method is the modification of modulus and other properties by adding ingredients which change the properties as the result of a purely physical mixture with the base composition. The second method is to vary the chemical composition of the base compound. Inasmuch as superficial examination of compositions for a particular service may be misleading it is possible that incorrect compositions may find application in spite of very definite shortcomings that could be eliminated by further study. For example, resilience and modulus are not necessarily related to the tendency of a spring to sag or creep under load. Therefore, there is no substitute for an actual evaluation of creep when this property must be carefully controlled.

Fig. 3 shows the relative creep of four compositions plotted logarithmically against time. Compound *A* is the basic composition and compounds *B*, *C*, and *D* are softer versions obtained by adding successively greater amounts of the same softening ingredient. This is a purely physical means of changing the modulus and it will be noted that compound *D*, which is the softest (see Table 1), shows very bad creep.

Fig. 4, on the other hand, shows that the same range of modulus may be covered without sacrificing creep to the same extent by using a different physical softener.

Fig. 5 shows a series of compounds containing increasing amounts of a type of carbon black. The creep data for compound *A* which have been placed on all of the other figures for comparison, were omitted from this figure to avoid confusion with other lines which would be very close to it. Under the fixed load of 47.7 psi the initial deflection in shear (Table 1) for these compounds varied from 9.1 to 35.1 per cent. It will be noted that in the order of increasing hardness the creep increases. It is also apparent, however, that the lines appear to be converging and that the initial order in creep might be reversed at some time well beyond the limit of the data shown.

TABLE 1 MECHANICAL DATA ON PHYSICAL MODIFICATIONS OF VULCANIZATE A OBTAINED BY THE USE OF SOFTENERS OR REINFORCING PARTICLES

Compound	Durometer A hardness	Initial shear in per cent under 47.7 psi	Relative creep at 200 hr, per cent	Compression modulus at zero load, psi	Resilience, per cent
A	47	40.6	20.6	520	87.3
B Softener	44	49.2	27.7	455	81.9
C *A*	40	62.4	44.0	400	78.1
D	37	68.6	85.0	370	79.2
E Softener	44	56.3	18.3	453	86.7
F *B*	41	64.4	19.2	385	85.9
G	38	68.0	20.6	335	85.9
H	35	76.2	24.5	313	85.4
I	52	35.1	17.0	690	86.6
J Reinforcement	60	24.3	20.0	933	83.1
K *A*	67	18.4	21.5	1235	77.2
L	73	12.5	22.7	..	72.0
M	78	9.1	25.9	..	60.4
O Reinforcement	53	33.0	18.7	675	85.6
P *B*	57	28.8	15.8	828	84.0
Q	61	23.2	16.6	995	82.7
R	71	19.8	13.9	1560	76.9
S	49	44.8	19–23	620	85.4
T Reinforcement	53	32.0	19–23	730	83.0
U *C*	59	27.4	19–23	985	80.9
V	67	18.6	19–23	1300	75.6
W	76	12.1	19–23	1800	69.3

Fig. 6 shows a series of compounds covering substantially the same modulus range as Fig. 5 but in this case it will be noted that as the modulus increases the creep decreases. It also appears that these data are divergent so that the order shown for the extent of the test presumably would not be changed if the test were further prolonged.

Fig. 7 shows the creep data for a series of compounds obtained

TABLE 2 MECHANICAL DATA ON VARIOUS VULCANIZATES UNMODIFIED BY PHYSICAL SOFTENERS OR REINFORCING AGENTS

Compound	Durometer A hardness	Initial shear in per cent under 47.7 psi	Relative creep at 200 hr, per cent	Compression modulus at zero load, psi	Resilience, per cent
A	47	40.6	20.6	520	87.3
BB	51	39.0	11.8	600	87.4
CC	46	49.2	13.2	515	85.7
DD	44	57.6	8.2	465	84.2
EE	45	59.5	16.8	505	78.0
FF	43	58.8	4.7	455	82.7
GG	39	65.8	7.1	400	78.8
HH	51	40.2	10.0	615	67.5
JJ (rubber)	35	71.5	6.0	No data	No data

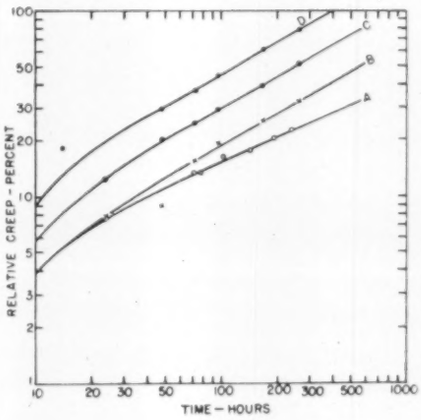

FIG. 3 THE EFFECT OF SOFTENER "A" ON RELATIVE CREEP

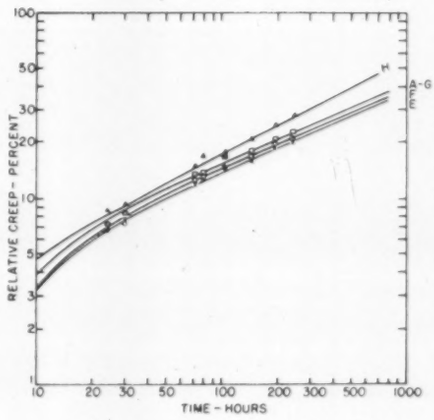

FIG. 4 THE EFFECT OF SOFTENER "B" ON RELATIVE CREEP

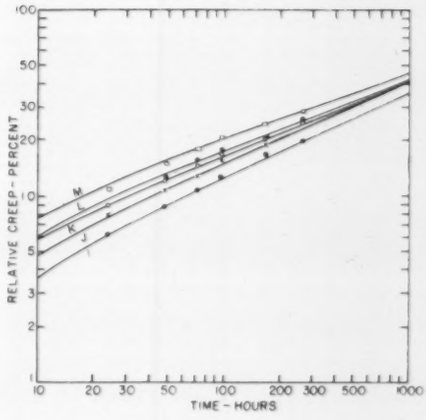

FIG. 5 THE EFFECT OF REINFORCEMENT "A" ON RELATIVE CREEP

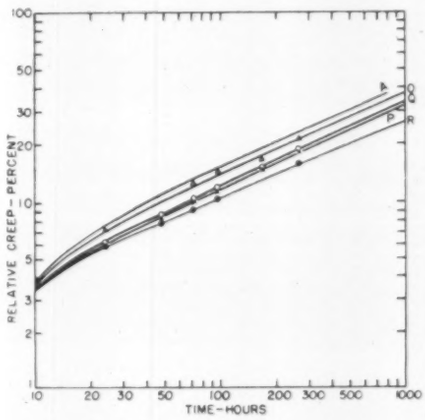

FIG. 6 THE EFFECT OF REINFORCEMENT "B" ON RELATIVE CREEP

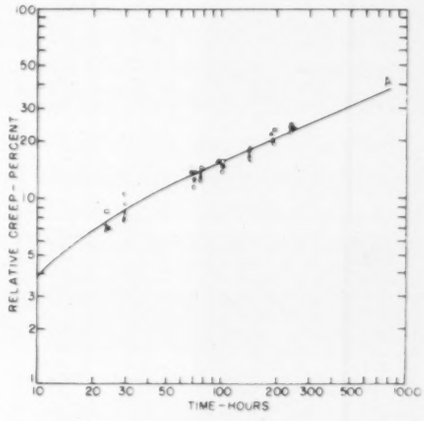

FIG. 7 THE EFFECT OF REINFORCEMENT "C" ON RELATIVE CREEP

by incorporating an intermediate type of carbon black in the compound to obtain creep characteristics intermediate between those of Figs. 5 and 6. No clear trend is shown for different amounts of black by these data, which do not appear to be either convergent or divergent over the range of the test. In reviewing Figs. 3 to 7 and the other characteristics for the compounds listed in Table 1, it can be seen that the rate of creep can be varied independently of the modulus and that there is no correlation between resilience and relative creep. In Fig. 5, for example, it is shown that the creep rate for compounds *I* to *M* increases, and Table 1 shows that there is at the same time a decrease in resilience. Fig. 6, however, shows that for the compounds from *O* to *R* the trend is toward a lower creep rate at the same time that the resilience is decreasing from 86 to 77 per cent.

In Fig. 8 data are given for a series of base compounds containing no physical modifiers such as softening or reinforcing agents. These cover a rather restricted range in modulus, but they cover a rather wide range in resilience and in relative creep. It will be noted that compound *A*, which has been the principal subject of the preceding portion of the paper, is the poorest of this group. Compound *JJ*, which is next to the best compound in this group, is a rubber control which is claimed to have marked resistance to creep. Reference to Fig. 8 and Table 2 shows again that there is no reliable correspondence between resilience and creep rate. As a specific example consider compounds *HH* and *BB*. At the end of 200 hr the creep of compound *HH* was 10 per cent. The creep of compound *BB* was 11.8 per cent. The resilience of these two compounds was 67.5 and 87.3 per cent, respectively.

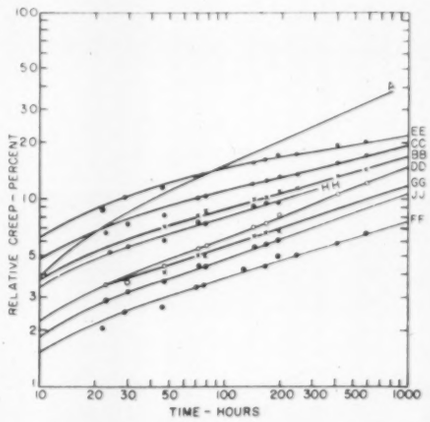

FIG. 8 THE RELATIVE CREEP OF VARIOUS BASIC VULCANIZATES OF NEOPRENE COMPARED WITH A RUBBER CONTROL "JJ"

The foregoing data illustrate the complexity of a very limited portion of the creep problem that must be studied in materials laboratories. As time goes on intensive work will bring about a better understanding of the field we have glanced at in this paper. It will also become increasingly necessary to thoroughly investigate other factors such as various loads, temperatures, and degrees of vibration.

MACHINING PROBLEMS *in* AIRCRAFT CONSTRUCTION

By J. P. JOHNSON

PRESIDENT, THE ARO EQUIPMENT CORPORATION, BRYAN, OHIO

THE machining problems which confront the aircraft mechanic today are in some respects no different than they were during the last war when large quantities of aircraft had to be produced in as short a time as possible. The quantities then, of course, were not as great as they are now, therefore, the difference in manufacturing methods 25 years ago and at present is a matter of a difference in volume, and a great difference in design. The designs of today lend themselves to quantity production ever so much better than they did 25 years ago. This is due to the many years of experience in building and testing modern aircraft, where some of the most difficult machining problems have been eliminated.

Owing to the constant improvements which are being made in modern aircraft, more and more items can be produced on a quantity basis, with the exception, however, of highly experimental items on new projects, where we must proceed with caution and tool up conservatively. This, of course, calls for a better class of skilled labor and makes these jobs semi-toolroom jobs. However, it cannot be emphasized too strongly that good machinability begins in the engineering department. Engineering departments which are manned by personnel who are familiar with machine-shop and foundry practice, in addition to their design ability, are best qualified to design aircraft units which can be machined with the least amount of trouble.

There is bound to be a certain percentage of scrap in even the best manned and equipped plants. This, of course, is due to the extreme accuracy required, where men must work to tolerances not required in other industries. This is a matter of which we are always conscious when employing men for our plants who have had no previous aircraft experience. Our ability to buy a much higher grade of machine tools than in the past has greatly assisted in the reduction of rejected parts and increased our ability to hold to the required tolerances. The greater quantities of aircraft units that are now being purchased has enabled us to make much better jigs and fixtures and special tools for intricate parts, as well as standard parts such as connecting rods, pistons, and gears.

WHAT THE NEW WORKER MUST LEARN

Many of our aircraft-production men have many years of experience to their credit. It is fortunate that some of them are available to help handle and train the great number of inexperienced men now coming into the aircraft industry.

I wish to point out a few of the principles of aircraft production with which new men must become familiar and which differ from other types of machine-shop practice. First of all, the new men must be taught to be honest in their workmanship. If they scrap a piece of work accidently or otherwise, they should be taught never to attempt to hide it. A company executive or foreman should never discharge a man who has been unfortunate enough to scrap some parts. In many instances men have been discharged for this, and their fear of being discharged has caused them to be dishonest and try to cover up. Such men are not necessarily dishonest.

It is very important that all employees should be taught the seriousness of allowing a bad piece of work to get into the mechanism of an airplane. They should be told that there are times when it is impossible to make emergency landings. Many times a bad piece of work can be responsible for an engine failure which may result in a forced landing. A landing gear may fail to come down and be the cause of an accident. Many cases could be mentioned where inspectors have found such defects in workmanship, and there is no doubt that a great many more have been passed by the inspectors unknown to them. Much of this difficulty can be avoided by education.

Cleanliness of the entire plant, the personnel, and all of the machines should be stressed and taught. Strict care must be given to all tools and fixtures, the cutting tools as well as the gaging tools. It is only necessary to study the successful plants of today to learn that care and cleanliness have been a great factor in their success. This is especially true of the aircraft-accessory plants.

The handling of the parts to be machined is also very important. Nothing should be thrown or roughly dropped, even if it is a casting or a forging; not that it would damage a casting or forging, but a principle must be established which will apply to the entire plant. When work is being handled from one operation to another, it should be laid on racks or trays, or neatly arranged in rows on a metal-topped bench. Metal-topped benches are specified, because these can be kept much cleaner with less effort than wooden benches. In this way, the floor inspector or foreman is able to pick up the last piece machined. He can determine this by its position in the rack, and so can stop defective work from being produced in quantities.

It is my belief that, in many aircraft plants, there is a lack of good floor inspectors, men who are qualified to assist the inexperienced workman, as well as to be of assistance to the foreman. Good inspection on the floor will prevent what we call long runs of scrap. The final-inspection department is the most costly place to find these errors. Personally, I have had some very discouraging moments when, coming into the final-inspection department, I have found long rows of expensive connecting rods, or other expensive parts with a dab of red paint on them indicating that they were scrap, because some floor inspector had neglected to watch his work or was incompetent.

PROBLEM OF RECRUITMENT

In general, aircraft machining should be classed with the highest grade of machine and tool work. It is no problem today, with good men and the good machine tools we now have, to hold tolerances of 0.0001 or 0.0002 in. in production. This, of course, is largely due to the better machine tools referred to. By far the greatest problem that we have confronting us today is the selection of men capable of running these machines and producing the parts to the tolerances re-

(*Continued on page 356*)

Contributed by the Aviation Division and presented at the Annual Meeting, New York, N. Y., Dec. 2–6, 1940, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

IMPROVISED METHODS *for* RAPID MUNITIONS MANUFACTURE

By GEORGE T. TRUNDLE, JR.

PRESIDENT, THE TRUNDLE ENGINEERING COMPANY, CLEVELAND, OHIO

IN THE present emergency, while we may desperately require new tools and equipment with which to speed up production, we cannot wait to rearm the nation until enough new machinery has been built to retool all the national-defense plants in this country. The job is too great!

The progress already made in this direction is amazing and yet it is only a start. According to reliable surveys made about a year ago, over 65 per cent of the metalworking equipment in the plants of this country was more than 10 years old. Under normal circumstances, plants seldom replace more than 5 per cent of their existing equipment per year.

On this basis, therefore, our facilities for making new equipment were geared to a moderate replacement rate. Can we expect them today suddenly to step up productivity to a rate ten, twenty, or fifty times their normal output?

Over the 10-year period ending with 1939, the machine-tool industry produced an average of about $100,000,000 worth of machine tools a year. In 1940, it turned out $450,000,000 worth and will produce at least $750,000,000 worth in 1941. Yet even with this incredible burst of speed in production, a thorough re-equipment of most of our manufacturing plants is still out of the question, especially since many of these new machine tools are going into completely new national-defense projects.

The fact is—and we may as well recognize it—that, in turning out defense supplies in the quantities and within the time required, most of the plants of this country are going to have to rely very heavily upon the old equipment already installed on factory floors, even though a large share of this equipment may be 5, 10, 15, or even 20 years old.

FITTING OLD EQUIPMENT INTO THE PRODUCTION SCHEME

The present concern of industry is, therefore, to determine the ways and means of making the best possible utilization of equipment already installed in the factories of the nation. Getting down to the basic philosophy underlying the entire problem, we find that men are involved as well as machines.

We have a lot of machinery, most of which is not new. We also have plenty of men, many of whom are not trained. It is self-evident, therefore, that neither the machines we have, nor the men we have, can do all the things we would like to have them do.

But what do we do as far as men are concerned? Do we sit down and wait for skilled men to be delivered to us? We know perfectly well we cannot do that. We know perfectly well that there is only a limited number of trained men available for the present emergency. Hence, we make the best possible use of the highly trained men we do have. Then, we do the best that we can with the men who are only partially trained and with those who have no training whatever. In the main, what we do with green men is to teach them to perform one operation.

Jake Schultz has just come in off the farm. Perhaps he has worked six months in a small-town garage. He has some mechanical aptitude, he is willing and honest, and we put him to work. He has very definite limitations. But we locate one job we think Jake can do, we break him in on that job, and the first thing you know, he is in production and doing his share in the National-Defense Program.

Now, why cannot we do exactly the same thing with machines? Take, for instance, an old drill press. It's not too good, it's nothing to brag about, it needs repairs, and it cannot turn out work the way a modern drill press would. But why not figure out a job for that particular drill press to do—just as we pick out a particular job for Jake Schultz to do? Why not put that drill press to work in spite of its limitations, just as we put Jake Schultz to work in spite of his limitations?

With skilled machinists as scarce and as badly needed as they are today, all of us instinctively try to reserve them for the important precision jobs which require the utmost skill. Other jobs can be handled by less skilled men.

On exactly the same basis, does it not seem sensible to reserve the most modern, efficient, and accurate machine tools for the very important precision jobs which have to be performed in this defense work, and get the rest of the work done on older machines which, if properly conditioned and assigned to the right job, can do the work well enough?

Think for a moment what can be accomplished by making maximum use of older equipment which is already on plant floors.

1 We reduce the tremendous demands placed today on machine-tool and machinery manufacturers; and I can assure you that any lightening of the load placed on them today would be extremely welcome.

2 We lessen the building up of excess plant capacity today which may boomerang tomorrow in the inevitable aftermath which must follow the national-defense expansion period.

3 We reduce the sum total of the taxpayers' bill for national defense—and remember, all of us have to share in paying this bill.

4 We get started on national-defense production more quickly. Instead of sitting on our hands and waiting for new machines, we go to work at once making the greatest possible use of such machinery as we now have.

And so I say that in my opinion today, the number-one job of every manufacturer who is now engaged directly or indirectly in national-defense production is to survey all of the equipment in his own plant as well as the equipment in plants to which he might be able to subcontract some of his work. Survey this equipment, figure out just what it can do, get some good maintenance and repair men on the job, get it in first-class working condition, and put it to work.

RELATION OF OLD MACHINES TO LABOR COSTS

A great many people apparently have serious doubts as to the practicability of such a program. They have the feeling that the job cannot be done fast enough on old equipment. They

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also have the idea that with old equipment, which does not have a high rate of productivity in comparison with modern equipment, labor costs will be unduly high and, therefore, the total production costs will be increased.

I wish to say most emphatically that in my opinion and on the basis of my experience, these assumptions are not in most cases justified by the facts; at least not to the extent which many people presuppose.

I have seen many instances in which old machines, reconditioned and properly tooled, and with the flow of work correctly adjusted, have turned out production at a cost surprisingly little higher than would have been the case with absolutely new machines. In fact, in some cases costs have been lower.

Many people have an exaggerated idea of the extent to which labor costs affect final costs. It is a matter of known statistics that on the average labor costs seldom amount to more than 20 per cent of the total cost of the product. Therefore, a 10 per cent increase in labor costs amounts to only 10 per cent of 20 per cent, which is 2 per cent of the total cost of the product. And that 2 per cent can usually be absorbed—in fact, more than absorbed—by intelligent factory management.

It is perfectly true that old, and perhaps semiobsolete, equipment cannot turn out work as fast as new and modern equipment. But what happens when you cannot get delivery on this new and modern equipment?

Suppose you are in New York and you get a wire to rush to Los Angeles. The best way is to take a plane or train. But suppose you cannot get a plane or train? Suppose there is a delay of two weeks on all ordinary means of transcontinental transportation? It is still perfectly true that the best way to go from New York to Los Angeles is by plane or train. But it is equally true that if you want to get to Los Angeles in a hurry, you would do better if instead of waiting for a plane or a train you jumped into a secondhand Ford and drove day and night. That is exactly the point I am making with respect to old existing equipment on plant floors.

I know of some cases where the production of defense materials has been held up for weeks because the company was waiting for one or two machines. I know of cases in which one half of a defense contract could have been completed on old machines while the company was sitting around waiting for the delivery of new machines.

Understand, this is no criticism of the builders of new machinery. They have done, as I said before, a perfectly amazing job—a better job than anyone could possibly expect. But I do say most emphatically that the quickest way of getting the job done today is to start to work it out with the equipment already on hand, instead of waiting for something better which may not arrive in time.

PUTTING NEW MEN AND OLD MACHINES TO WORK

Let us study the list of some of the major types of machine tools common to most plants and see what can be done on the older and even obsolete machines.

Let us start with planers and shapers. These machines do not perform multiple operations and therefore in their very nature cannot be too complicated. The basic principles of older machines of this type are much the same as are the basic principles of newer machines. Older machines cannot do as rapid a job as new machines but, if they are given a good overhauling, they can do a good job on defense production.

It takes a pretty good man to operate a planer or a shaper, but it does not take a top-notch machinist, and a man can be trained to do one particular job on one particular machine in fairly short order. So, let us put all our planers and shapers to work, including all those on our own floors, on subcontractors' floors, and, incidentally, all of the secondhand planers and shapers standing idle on dealers' floors if they are needed in the defense program.

Take milling machines next. There have been many improvements in these machines in recent years; both horizontal and vertical types. But the basic principles of these machines still remain much the same. The vertical milling machine may be used as a profiling machine where operations are performed in different planes, while the horizontal milling machine is used as a rather universal machine in the toolroom. But on the production line, which is where we need machines for national-defense purposes, both vertical and horizontal milling machines are single-purpose machines; once properly tooled, neither requires any special degree of skill to operate.

In short, we can take old milling machines, set them up for one operation, train men in a short period of time to do this one operation, and get them into production right away.

Now, take drill presses—large and small, bench type, automatics, and radial. Of course there have been major improvements in drill presses in recent years. New machines are much more rigid and have a higher spindle speed. These naturally came hand in hand with better cutting tools. But just the same, the drill press of 10 to 20 years ago does much the same job as a drill press today. It does not do it as rapidly, but it does it nevertheless, and an operator is easily trained to do one particular job on a drill press. So let us take the old drill press, set it up for one operation, train a man to do that job, and put that machine and that man to work.

In the toolroom, the lathe is an all-purpose machine. To get complete utilization and accurate work on the lathe in the toolroom, it requires a highly skilled mechanic. But, in the production line, the lathe is set up as a one-purpose machine. It is far simpler and requires less skill on the part of the operator to do one operation at a time; for instance, all the taper-turning at one time, and all the chasing of the threads at one time. It makes no difference whether both these operations are done on the same machine, or whether they are done on different machines.

There have been great improvements in lathes in recent years, in rigidity, in power, in speed selection, and in feeds. But though these improvements enable the new machine to do more work, the work can still be done on the older machines. Furthermore, there are not a lot of complicated gadgets on a lathe; a fairly intelligent man can learn how to operate a lathe in short order. And when a lathe is set up in the production line for a single operation, even a green man can master that operation in a few weeks. Let us get all our old lathes tuned up and put to work.

Among the various types of grinders, the universal is used chiefly for toolroom purposes, but the internal, the centerless, and the surface grinders are production machines.

Great improvements have been made in grinders in recent years. They have more rigidity, better slides, better bearings, and wheel adjustments. But, nevertheless, old grinders will still do a job on the production line. They are sufficiently accurate and reliable to meet most requirements on defense work. A man can be trained in short order to do a pretty good job on a grinder set up for one operation. Let us get all our old grinders into production.

Now, take the boring mill. This particular machine has always interested me because, in my opinion, there have never been enough of them. Why? Because of the ingenuity of our mechanics. Our mechanics have gotten many of their boring jobs done on the lathe, the milling machine, and the drill press.

Since we still have a shortage of boring mills and we still have the ingenuity of our mechanics, we might as well accept facts as they are and make the best of them. Let us do as much

of this work as we possibly can on the lathe, the milling machine, and the drill press.

There is an added reason for this. The boring mill is a precision instrument. It requires a top mechanic to operate it. But, with proper jigs and fixtures, the lathe, the milling machine, and the drill press take less skill. It is easier to train new men to operate them. Let us save the new boring mills for those defense-production jobs that need them most, for work requiring extremely close tolerances.

AUTOMATIC MACHINES HAVE SPECIALIZED DEFENSE-PRODUCTION ROLE

After putting to work planers, shapers, milling machines, drill presses, lathes, grinders, and boring mills of an older type which can be operated to advantage in the National-Defense Program, what is left? The one major group which I have not yet discussed is the automatic and semiautomatic machines which perform many operations on the same piece at the same time, or in a series of stations. I am referring, of course, to the automatic multiple-spindle screw machine, the automatic single-spindle screw machine, automatic chucking machines, both vertical and horizontal, and similar equipment for multiple operations.

These machines are the marvels of modern machine design and engineering. The things that they can do are absolutely incredible. I heard the other day that a machine had been devised for a certain job in aircraft-engine production, which had 51 stations, with more than one operation performed at several of the stations.

The degree of productivity, efficiency, and accuracy made possible by some of these new intricate machines is amazing. There are only two difficulties in connection with them:

The first is to get delivery.

The second is to get them into production the moment they are delivered.

No matter how great the urgency may be, it takes time to engineer, design, and produce machines of this type. The fact that so many of these complex machines have already been made and delivered is a tribute to the genius of this country's machine-tool builders. But machine-tool builders cannot simply snap their fingers and bring these machines into existence overnight.

Once these complex machines are finally delivered and installed, it may take not simply a top mechanic, but practically an engineer, to get them started on production. In the process, there is often a certain inevitable delay.

As an illustration: Not long ago, I spent three hours in a certain plant which had just received delivery of a multi-operation machine. The men in the plant were trying to get it into production. On one particular operation out of the twenty one which it performed, it was not sufficiently accurate. The question was how to get the desired accuracy on that one particular operation. It was probably just a matter of trial and adjustment, but it took time. But meanwhile, as far as actual production was concerned, this machine was a total loss. Furthermore, this plant had been waiting for this machine for something like six months.

I have no desire to disparage the importance and usefulness of that new machine. But, at the same time, from personal observation and study of the machine tools standing on the floor of that plant, if production on its defense contract had been started with its old tools without waiting for this new machine, one half of the job would already have been done.

These new, amazing machine tools represent incredible progress in metalworking. They are vitally needed today for certain jobs in defense production which have no counterpart in peacetime production. It takes a special machine, for instance, to bore a big gun. Certain operations in the manufacture of airplane engines require special new machines both because of the extreme accuracy demanded and because of the peculiar nature of these operations. Jobs such as these cannot be done on old, existing equipment, even with highly skilled mechanics.

May I urge most earnestly, therefore, that more of these new machines go into the specialized defense production which needs them most, and that those industries which can do their defense-production work on existing machines put more emphasis on this end of the job, and spend less time waiting for new machines which are much more necessary elsewhere.

ADAPTING OLDER TOOLS TO DEFENSE-PRODUCTION REQUIREMENTS

This brings us right back again to old equipment now standing on the floors of the factories of this country. It is my firm belief that there is more of this equipment, old but still productive, in existence in the United States than has yet been revealed by any survey hitherto undertaken.

Every time a plant buys the latest-model machine tools, old machine tools go some place else. They move to another plant. That plant in turn throws out its older equipment. This moves to smaller plants. It keeps moving down until eventually you find it in garages or barns. Much of it is still belt-driven; some of it is even left-handed. But a good dose of maintenance will put practically all of this equipment in shape for some particular operation in defense production.

A practical production man knows how to use these machines. He knows their limitations and he knows their possibilities. Here are some practical illustrations:

If an old machine will not hold a reamed hole to size, rough it on the old machine, take it off, and ream it on a more accurate machine.

If an old machine will not hold the thread to size, rough it on the old machine, take it off, and run a die over it by machine or by hand.

If an old machine will not hold concentricity or an accurate outside diameter, make a secondary operation of it on another machine.

You would be amazed at the production possibilities of a large battery of bench lathes, bench milling machines, and bench drill presses for secondary operations on small parts. And here is a further angle on secondary operations:

The author is convinced that considerable production time is lost in certain cases by attempting to perform, on modern multiple-operation machines, all of the operations which they are capable of performing. Take, for instance, a machine that is supposed to perform fifteen operations; one particular operation out of these fifteen may be an operation which requires special accuracy. It may also require unusual skill on the part of the operator. If there is any trouble with this particular operation, it slows up the productivity of the machine with respect to all of the other fourteen operations.

Logically the answer is to take this one troublesome operation off this multiple-operation machine. Let the new machine perform the other fourteen operations which it can do without any delay and trouble. Make this one particularly difficult and accurate operation a secondary operation. Put it on a single-purpose machine set up to do that particular job, with an operator trained to accomplish it.

By that method, the new machine can be kept going full tilt in the hands of an operator having only slight experience, who can watch the automatic functioning of the fourteen operations which are easy, and keep up with the machine by putting the

only difficult operation onto another machine, in the hands of an operator who can be trained to achieve the accuracy required.

Reverting to a principle which was previously set forth, somehow, we must arrive at a proper relationship between men and machines. Since we have a shortage of experienced and skilled machinists, we cannot expect to set up our machine operations on a basis which requires a majority of thoroughly trained men. Somehow, we must break down our operations so that they will not require a great number of men trained to a variety of operations. We must set up our production equipment and plans in such a way as to make maximum use of men trained to perform one particular operation on one machine. There simply is not time to train enough men beyond that point.

We cannot advance the complexity of our machine tools beyond the capacity of the majority of our men to understand and operate them. We are limited by the human factor, as well as by the obvious physical impossibility of producing overnight enough new machines to re-equip all of our plants to the extent which today we might think desirable.

So again I say—tune up the old machine to do one particular job, and train a man to do it. And keep man and machine at work!

Today, wars are not won at the front. They are won in factories. Gains are made not in terms of miles advanced—they are made in terms of production increases. The success of this country in its national-defense effort rests upon our capacity to speed up production. The author claims that production can best be speeded up today by putting into operation every possible existing machine, whether it be 5 or even 30 years old.

MODERN MONSTER

(Photograph taken by Leonard Cchtman, Jr., and shown at the Fifth Annual Photographic Exhibit held during the A.S.M.E. Annual Meeting, Dec. 2–6, 1940, New York, N. Y.)

MERCURY VAPOR *for* CENTRAL-STATION POWER

By W. L. R. EMMET

A.S.M.E. MEDALIST, 1929

THE Emmet mercury-vapor process has been talked about for a very long time and its uses have been few and are limited in the matter of success or demonstration of practicability for general use, and in the meantime great advances have been made in uses of high-pressure steam and in the apparatus and materials needed to produce it.

The high fuel economies shown in some high-pressure steam stations may have led many power producers to assume that, notwithstanding its thermodynamic advantages, the mercury process could not be justified for large power production under modern conditions. The purpose of this paper is to show that such an assumption is radically wrong.

HARTFORD INSTALLATION

The only mercury installation which has been in continuous service for a long period of time is that in the South Meadow station of the Hartford Electric Light Company which has been in service for many years. A side elevation is shown in Fig. 1.

The degree of success accomplished at Hartford can be best shown by quoting a report of T. H. Soren. From this it will be seen that the limitations of this equipment have been confined to the boiler alone and that in all other respects there has been unqualified success.

REPORT OF THE MERCURY BOILER INSTALLED AT SOUTH MEADOW PLANT, HARTFORD ELECTRIC LIGHT COMPANY, MAY 23, 1939

The mercury boiler at South Meadow station was started in October, 1928. It immediately became evident that certain changes were necessary, which were completed in February, 1930. During the year from February, 1930, to 1931, the boiler operated a total of 6909 hr, using pulverized coal. In February, 1931, the design of the tubes of the mercury heater was found to be inadequate and they were replaced. The unit was again started in March, 1932, burning oil. During the years 1930, and 1932 to 1938, inclusive, the unit gave satisfactory service. During these eight years it operated a total of 57,032 hr, and generated from the mercury turbine 397,600,000 kwhr, and the total net produced, including generation from steam produced by the condenser-boilers, was 958,000,000 kwhr. The average rate, including all fuel used during the period of eight years, was 10,374 Btu per kwhr. From 1934 to 1938, the unit was on the line 85 per cent of the total hours of that period. In addition to the time for repairs on the unit proper, it was out of service, during these five years, for repairs and maintenance on air preheater, furnace walls, steam economizers, superheater, fans, main generator, and exciter. With these items eliminated, the mercury cycle itself was available 90.8 per cent of the time. The principal reason for interruption of service was due to poor welding, which was done in 1927 and 1928 before the technique was highly developed. The greatest single source of trouble was due to the butt welding of the cup-shaped tip of the tubes built in 1931. There were 3080 tubes and 18 of these butt welds have failed.

The second cause of interruption has been the accumulations of oxide, iron oxide, oxide of mercury, in the space between the core and the top of the tube. This accumulation has to be removed by dissolving it with acid, as the space is not accessible for mechanical cleaning.

Presented at the Spring Meeting, Atlanta, Ga., March 31–April 3, 1941, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

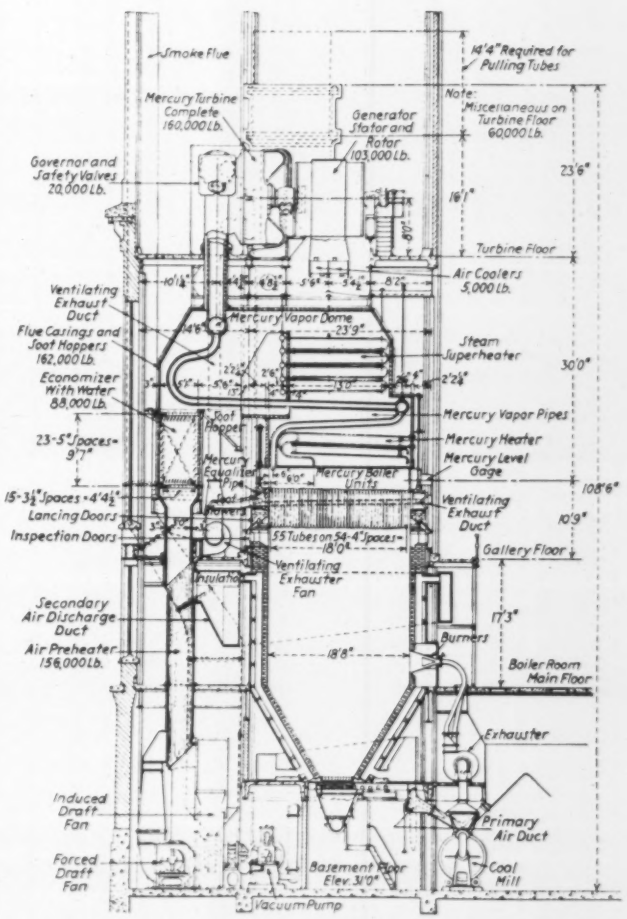

FIG. 1 10,000-KW MERCURY INSTALLATION AT HARTFORD

The operation at 10,000 kw capacity of the mercury unit required several shutdowns for cleaning during the year. The time required for cleaning has been materially reduced by running the boiler at slightly lower temperature and lower capacity, so that it is now operated at approximately 80 per cent rating.

The mercury detectors were developed several years ago, and since these were put in service, there has been ample notification of leaks, so that the total loss of mercury from leakage has been negligible.

The mercury-turbine condition is comparable to the steam turbine with the same operating record. It shows only a reasonable amount of erosion on the last stage.

The condenser for the production of steam was cleaned in 1931 and some of the tubes showed considerable scale deposit. This was removed. Shortly after this cleaning the boiler feedwater was placed under the Hall system of control, and inspection in 1935 showed very little scale, proving the effectiveness of the treatment. Scale deposit is negligible, as the metal temperature is never more than 20 F above the steam temperature in the condenser. The maintenance cost for the last five years, including make-up mercury, is as follows:

	Cost, mills per kwhr	Output, millions of kwhr
1934	0.195	124
1935	0.228	122
1936	0.197	129
1937	0.183	125
1938	0.145	123

The descending scale of costs is due to the more systematic manner of handling maintenance and repair. The cost of maintaining the steam-generating equipment, condensers, etc., is not included.

The maintenance cost of the mercury unit includes all charges against the mercury plant and its attendant accessories.

When this installation was undertaken our experimental knowledge was admittedly imperfect, but the progressive spirit of the management of the Hartford Company considered the step justified and presumably have never changed their opinion. The designs of this installation were made with great care in the private office of the author and B. P. Coulson, Jr., who has helped in the production of this paper, produced the original idea on which the type of boiler was based, and was active in all of the details of experimentation, production, and tests. These tests showed conditions and economies in almost exact agreement with predictions.

PURPOSE OF DESIGN

The purpose of the design of the Hartford installation was to produce a mercury unit of practicable and convenient dimensions which could be introduced into existing power stations, thus affording a steam source which in existing buildings could be substituted for all or part of the steam boilers in use, and so giving, through the output of the mercury turbines, a very large increase of capacity with very small addition to the fuel required.

When steam is made through the medium of the mercury process, the fuel required for its production is generally only about 15 per cent greater than when it is produced in steam boilers, but the power added by the mercury turbines may be 75 per cent or more of that produced by the steam.

These ratios are of course governed by the pressures of steam and mercury used and by other conditions but give a fair idea of the possibilities.

Since the Hartford installation was made, much has been learned about the vaporization of mercury and also about methods of construction applicable to conditions met in the high-temperature work incident to the most economical use of mercury vapor for power, and the purpose of the present paper is to show how present-day knowledge can be applied to such an undertaking as was attempted at Hartford.

SIZE OF UNITS

Conditions with mercury are such that no gain can be accomplished, either in cost or fuel economy, by using very large units, as has become common in steam practice. There are many reasons for this even if a new large mercury station were to be built.

At the time when the Hartford installation was made, its size was thought suitable to the purposes already stated, and in the opinion of the author that condition has not greatly changed. The mercury turbine and generator at Hartford are suited with slight changes of nozzle and bucket dimensions for use at 12,000 kw from the generator with very effective conditions of pressures and efficiency and the present study may be regarded as an up-to-date 12,000-kw application of the Hartford idea.

BOILER PROBLEM

As may be judged from Mr. Soren's report, the only feature of the Hartford installation which has not been up to the expectations of its designers is the mercury boiler, and its limitations, as shown by experience, years ago convinced the author that a more practical and cheaper form of boiler must be discovered before this process could attain general commercial success.

Since that time, many mercury boilers have been designed and there have been very wide differences of opinion concerning the types which might be justified by commercial conditions. Very large expenditures have been made for the General Electric Company in mercury developments and testing and the experiences have brought forth very valuable knowledge which if now properly applied will bring this process to wonderful degrees of usefulness.

The author during these years, being long retired, has not been in a position to control or greatly influence most of these activities, but has found opportunity to obtain certain experimental knowledge concerning a type of boiler the idea of which was conceived about six years ago, and the possibilities of which have been shown by two experimental units, the second of which was installed at the Pittsfield works of the General Electric Company and kept in operation there for several months at the load for which it had been designed.

Mercury boilers of this type have not been adopted by the General Electric engineers, and what is here said concerning the type is simply the opinion of the author who, being the inventor of the process, has desired in his retirement to do what he could to bring it to commercial usefulness.

This Pittsfield boiler is illustrated by Fig. 2 which gives its proportions and serves to illustrate its principle, but does not show the means by which it is carried and supported.

This boiler was designed to make 110,000 lb of mercury vapor per hour at about 100-psi pressure, and to be fired by oil from one burner upward from the bottom. Its walls were covered by 120 tubes the dimensions of which in these lower parts were $^5/_8$ in., and 1 in., outside diameter. They were spaced $1^3/_4$

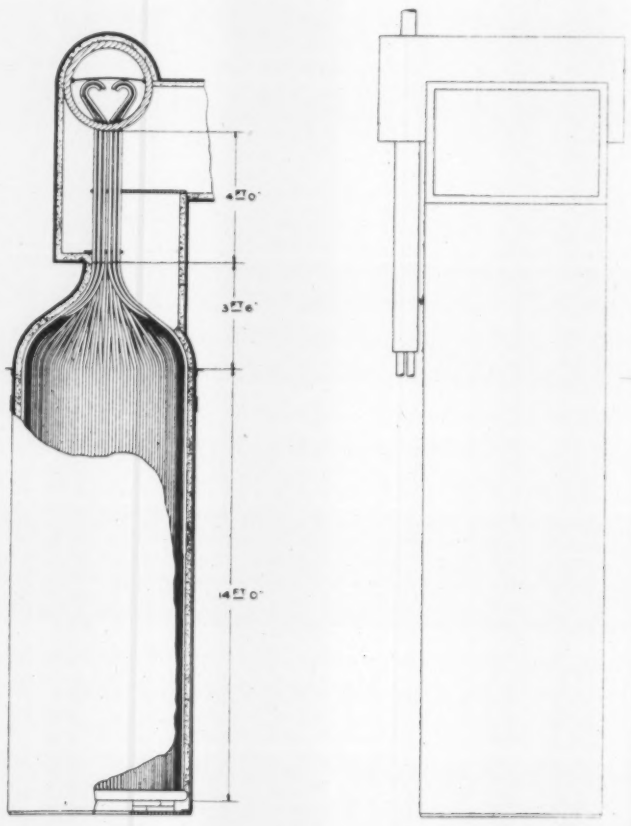

FIG. 2 MERCURY BOILER AT PITTSFIELD

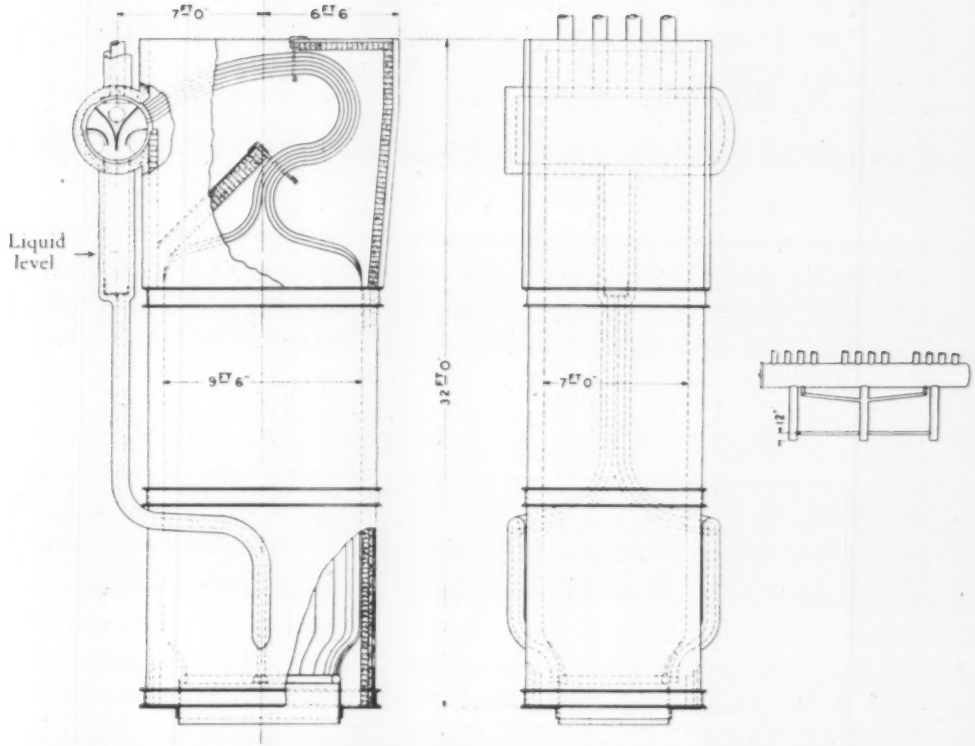

FIG. 3 ONE BOILER UNIT OF THE GROUP OF SIX SHOWN IN FIG. 4

in. on centers and this arrangement gives an internal diameter of chamber of about $5^1/_2$ ft.

The vertical dimensions are shown by the drawing. The tube size given extends up for about 8 ft and above that the inside diameter is $^7/_8$ in. The idea of this design was to give a condition where a maximum amount of heat should be delivered by radiation to parts of the tubes, which, being well filled with circulating mercury, were safely capable of receiving it and a less amount where the tubes, having more vapor and less liquid, might be less capable of taking heat.

The author's idea was that the gases and flame in combustion chambers might be quite opaque to radiant heat, and that proximity would greatly help the effect. Hence the long and narrow shape of the combustion chamber. Thus our expectation was to get high temperatures, and very high radiant-heat delivery near the bottom, and rapidly falling temperature with less, but still considerable, radiant-heat delivery toward the top.

Our first experiment with this type of boiler showed that the conditions hoped for were realized to a degree beyond expectations. The arrangement of tube ends in the drum of this Pittsfield boiler, as shown, gave entire freedom from priming of mercury liquid with the vapor, an object which is much more simply accomplished by the drum arrangement shown in Fig. 3 which shows a larger unit of the same type and principle.

Elaborate experimentation with individual tubes of this type has shown that they can be operated with very small quantities of mercury, only the lower part has to be filled when the firing starts. The upper parts receive less heat, and are given good safe heat transfer by a spray of mercury carried forward by the flow of vapor.

In the design shown in Fig. 4 six small units are connected to a single vapor drum and operate together as one boiler. Each is fired separately and delivers its share of vapor and circulating liquid to the main drum. The liquid run down from the different sections, which may be unequally fired, can, by cross connections, be made to mix to any desired extent so that the condition of the mercury circulating in all can be kept practically uniform. This is a very important matter, since it is desirable to use certain alloys in the mercury in boilers and since a lack of constant mixing would soon cause unequal distribution of these alloys.

In the drawing it will be seen that the liquid level at start is near the bottom of the run-down drums so that all the upper reaches of tubes are then empty. The possibility of such segregations of alloy content has been the principal argument against the use of such a multiple-unit arrangement, but very thorough experimentation with the nature of action in such tubes has shown that no difficulty of the kind could occur if the circulating arrangements are properly made. A plan for circulation is shown by Fig. 3.

Experience with other mercury boilers led the author to adopt in this type an arrangement by which all tubes would be subjected to equal heat delivery and liquid circulation and so arranged that every tube was conveniently accessible for the passage of a rotary cleaner if such cleaning should ever be needed. This matter of cleaning is one of vital importance in mercury boilers and this type is the only design in which it has been provided. The various reasons for the importance of this matter of cleaning cannot be gone into here, but are amply shown by many experiences.

It may be said that as matter of general principle, the larger a mercury boiler is made the more it will cost per kilowatt of capacity and the more mercury it will require in proportion to its rating.

A LARGE BOILER UNIT

In Fig. 5 is shown the approximate dimensions of a single-boiler unit which has been recently designed to do the same work that is here proposed for the group of six units here proposed, and the figures in Table 1 comparing the designs will illustrate what has been said.

The weight of tubing required in the two designs is not widely different, but the cost of tubing for the single-unit boiler is much higher. Strains from gravity and other conditions

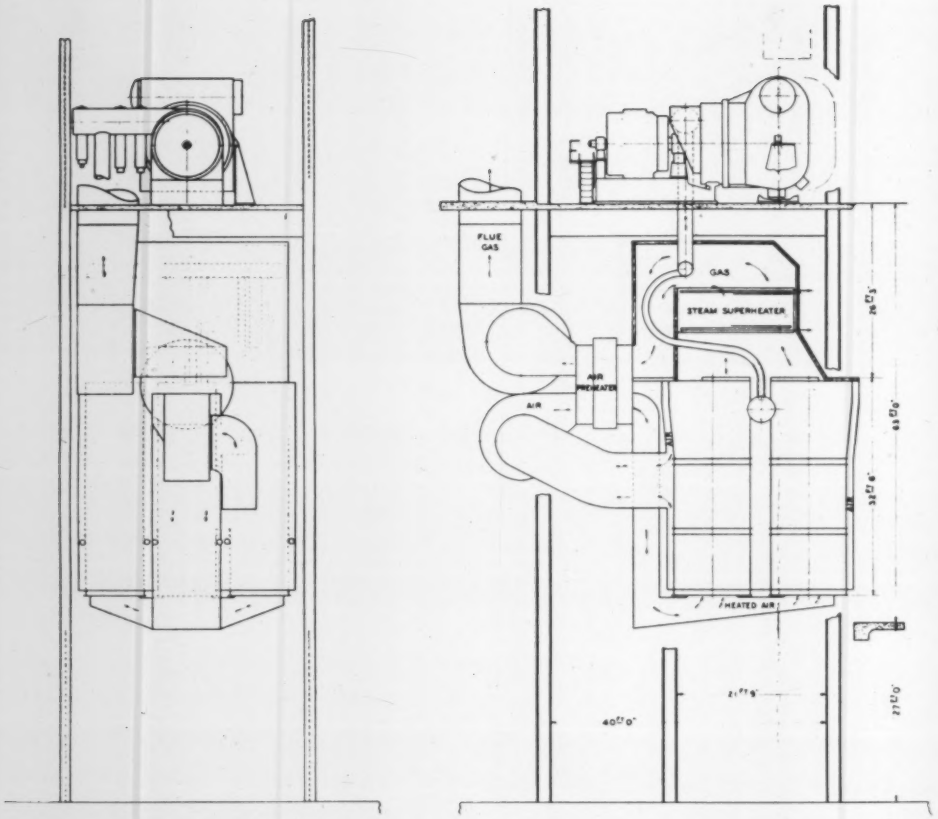

FIG. 4 GROUP DESIGNED FOR 12,000 KW FROM MERCURY TURBINE

TABLE 1 COMPARISON OF SINGLE-UNIT AND MULTIPLE-UNIT BOILERS

	One-unit boiler	Six-unit boiler
Combustion-chamber volume, cu ft	82000	56000
Radiant-heat-absorbing surface, sq ft	2911	3420
Maximum distance of tubes from center of combustion stream, ft	9	3 1/2
Approximate weight of drums, lb	20000	10000
Quantity of mercury in boiler with mercury heater in one unit case with 10 per cent allowance for errors for dimensions, etc., lb	160000	108000

have caused the designers to adopt high-temperature metals for all of the tubes and some of these metals cost three times as much as ordinary steel. In the six-unit boiler high-temperature steel is only used in the lower ends of tubes which are in the hot end of the furnace, the method of support being such that no tube can be subject to appreciable strain, either through gravity or expansion.

In the six-unit design every tube is easily accessible to a rotary cleaner, while in the other such cleaning is impossible. In the six units there are no nearly horizontal reaches of tube while in the other there are many, and experience has shown that such reaches may be subject to dirt accumulations.

The insulated casings required to cover and contain the six units are considerably greater in area than those in the single unit, but in the six-unit design it is proposed to have all units inside of a sheet-metal enclosure through which the combustion air is drawn, so that the greater insulated area will not involve a greater heat loss.

MERCURY CONDENSER

The device shown in Fig. 6 is a steam-making boiler to which the heat is delivered by condensation of mercury vapor from

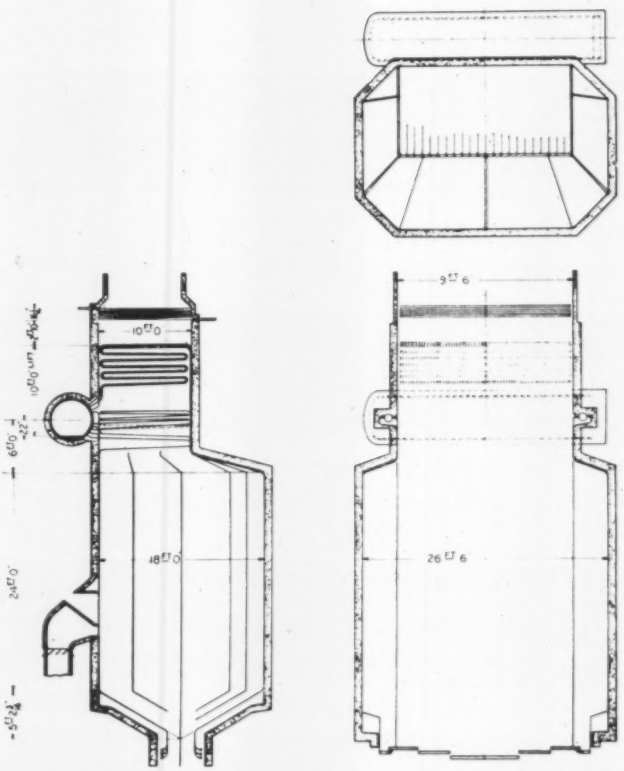

FIG. 5 SINGLE MERCURY BOILER DESIGNED FOR 12,000 KW

the turbine and is designed in this way to give economy in construction, facility of cleaning, absence of expansion strains, effective access of vapor to surface, and efficient removal of noncondensables.

Like other steam boilers, this with certain kinds of water will have to be cleaned out from time to time. While natural circulation cannot be expected to keep the interior of tubes clean or free from accumulation of solids at the bottom, they should be less troubled by scale accumulations than the dead-ended vertical tubes which have been used and far easier to clean. Note Mr. Soren's statement that the Hartford condenser tubes have not needed cleaning in several years. This condenser is attached to the turbine by a vacuum-tight connection and can be moved back from it to give room for the removal of wheels and diaphragms.

This condenser design has been criticized on the ground the circulation could not be expected through the tubes from back to front. This is to some extent true although the legs of the tubes nearest to the turbine ought to get much more heat. The action in the matter of water circulation should be better than that of dead-ended vertical tubes which have been used in existing mercury installations. Conditions reported in Hartford would indicate that with reasonable attention to water and to cleaning there should be no trouble.

THE TURBINE

The mercury turbine shown in Fig. 6 is similar in character and speed to that used at Hartford, but is made without steel castings in a manner which should be economical and safe. The bucket attachments are like those used at Hartford which have proved to be good. They can be machined and made interchangeable with forming tools and are amply strong and free from possibility of vibration troubles.

The wheels are mounted on the overhung end of the shaft as at Hartford, but the shaft packing is at the high-pressure end while at Hartford it is at the vacuum end; vacuum is held back of the packing by holes which connect to the hollow end of the shaft.

The type of packing shown is an improved form of that used at Hartford, and in the belief of the author would be practical and economical. In other mercury turbines centrifugal mercury packings have been recently used with very good results, and if desirable could be applied to this design.

The mercury throttle and safety valves are similar in character to those used at Hartford, but are made without castings and instead of using steel accordions to prevent leakage around the stems, a barometric mercury seal is provided by a suitable arrangement of concentric tubes with a vacuum connection above them.

The movement of valves can be governed just as it is in Hartford, a cheap and simple method which has been entirely successful.

GROUP ARRANGEMENT

The group shown in Fig. 4 is designed to give 12,000 kw from the mercury-turbine generator and to produce 155,800 lb of steam per hour both under such conditions of pressure, temperature, and heat transfer as are shown by figures given later in this paper, and the purpose is to do this with maximum efficiency and minimum expense for apparatus, mercury, and supporting structures, and with a minimum occupation of space.

Fig. 4 shows nothing but the apparatus itself and necessary weight-carrying structures, but should be sufficient to show how such apparatus could be put into existing power stations. The units of which the boiler is made up, shown in Fig. 3, form their own supporting structures, so that nothing is necessary other than a floor or framework upon which to stand them, and two light stanchions to take the weight of the drum. They are so designed that they can be shipped almost complete on freight cars, or the tubes can be properly bent and shipped for assembly on the ground. Repetition production of such units must tend greatly to reduce their cost and save much expense and risk by avoiding the necessity of a new boiler design for every mercury installation.

KIND OF FUEL

The figures given for this equipment are all based upon the use of oil fuel, that being the only fuel with which experience has been had in this type of boiler. The author, however, has reason to believe that these units are suited to use with pulverized coal, because experience has shown that there will always be a relatively low temperature at the top where gases pass out of the combustion chamber.

In the one-unit boiler shown on Fig. 5 a temperature of 2000 F near the top is expected and if the surface there became coated with ash or slag this temperature would naturally increase, while in the chambers of the six-unit boiler the temperature at the top of combustion chamber should always be below 16,000 F and with good coal the ash ought to pass out as dust and not coat or slag the tubes.

PRICE

The author can form no idea as to the prices which might be thought expedient if such equipment as is here shown were

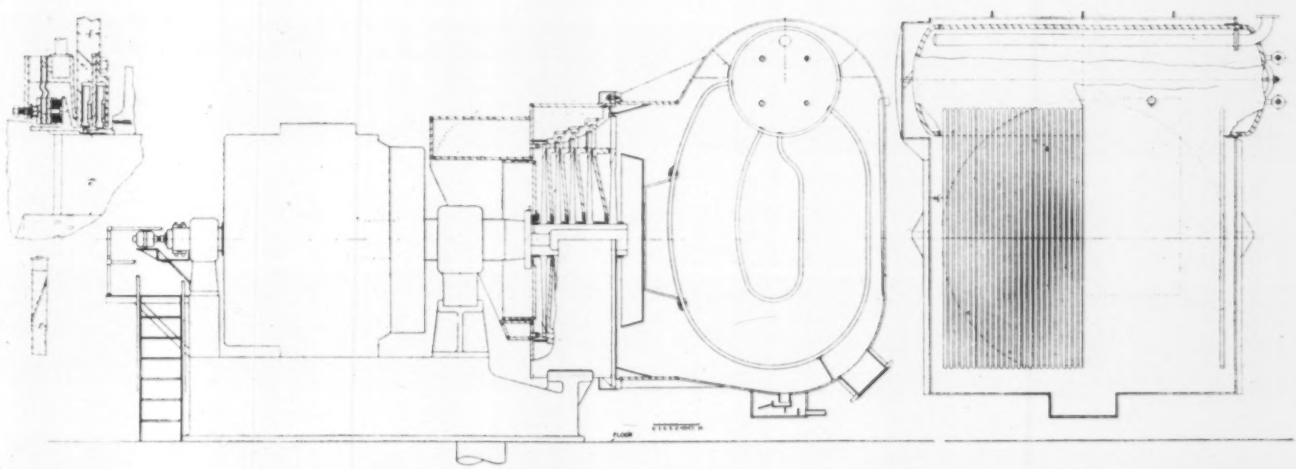

FIG. 6 GENERATOR, TURBINE, AND MERCURY CONDENSER FOR 12,000 KW

manufactured and sold, but since first cost is vital in new undertakings, certain comparative studies have been made from weight, surfaces, etc., of other apparatus.

These comparisons with selling prices of other power-station equipment would indicate that if such parts as are here shown come into general use the combined selling price for turbine, generator, mercury condenser, mercury boilers, superheater, air preheater, and 112,000 lb of mercury at $2 per lb might not exceed $80 per kw for the 12,000 kw of mercury power added, and it should be remembered that capacity for generating 155,800 lb of superheated steam per hour is also provided.

The actual cost in any case would be greatly affected by the building changes which would be required.

RESULTS OBTAINABLE

The equipment here shown is designed to give the best results possible in the production of power from mercury vapor and steam from the mercury exhaust for use in any manner which may be expedient.

The steam pressure considered corresponds to a moderate mercury vacuum and makes possible a good result with a simple mercury turbine. The steam figures given in Table 2 relate to such degrees of economy in the use of steam as are practicable in large and well-designed steam stations.

TABLE 2 DATA AND ESTIMATED RESULTS OBTAINABLE

Mercury Conditions	
Rating of mercury generating unit, kw	12,000
Mercury pressure at turbine bowls, psi, abs	140
Temperature at turbine bowls, F	959
Pressure in mercury condenser, F	481
Mercury vapor produced, lb per hr	1,298,400
Steam Conditions	
Steam produced, lb per hr	155,800
Steam pressure, psi, abs	400
Steam temperature, F	800
Feedwater temperature, F	340
Power normally producible from steam, kw	16,556
Power from steam and mercury, kw	28,556
Auxiliary power at 2.5%, kw	714
Net combined load, kw	27,842
Combustion Conditions	
Fuel used, oil, Btu per lb	18,500
Fuel burned, lb per hr	13,325
Quantity of air used, lb per hr	213,175
Flue gas produced, lb per hr	226,500
Temperature of air to burners, F	600
Air Preheater	
Ljungstrom type	C.G.Z.X.
Temperature of air entering, F	80
Temperature of air leaving, F	600
Temperature of gas entering, F	745
Temperature of gas leaving, F	298
Steam Superheater	
Temperature of steam entering, F	454
Temperature of steam leaving, F	800
Temperature of gas entering, F	1,271
Temperature of gas leaving, F	745
Superheater surface, sq ft	11,000
Losses Estimated	
Through hydrogen content in fuel, per cent	6.10
Moisture in fuel, per cent	0.03
Radiation and unaccounted, per cent	2.00
Total combustion loss, per cent	8.13
Stack loss, per cent	4.87
Total boiler loss, per cent	13.00

The losses figured on mercury and steam generating units are based upon experience with such apparatus and are conservative.

Producing 27,842 kw net from 13,325 lb of 18,500 Btu fuel oil per hour implies a thermal efficiency of 38.58 per cent.

HIGH-TEMPERATURE TOPPING UNITS

High-pressure steam boilers and turbine generating units have been much used in recent years to station turbines which operate at lower pressures, and an object of this paper is to show the great superiority of the mercury process for accomplishing the objects sought in such cases.

Under such steam conditions as are discussed herein, it has been figured that the use of mercury boilers and generating units for such topping purposes will add nearly two and one-half times as much power capacity as would be afforded if 1200-psi steam were used for the same purpose.

Mercury units can be used to make steam at any desired pressure, and in stations using pressures higher than that herein stated, the gain in output by the mercury over 1200-psi steam topping units would be still greater.

Machining Problems in Aircraft Construction

(Continued from page 346)

quired. Training such men cannot be accomplished quickly. It is fortunate that time is required to tool and install machinery and add new buildings, as this time can be used to train new men to operate the equipment. It is plain to be seen that, if we were able to buy all the tools and machines and install them tomorrow, we would still have this man problem—without enough inspectors or skilled men to act as instructors.

In the last few years, there have not been many good mechanics out of work. It certainly does not react to the benefit of the aircraft industry for one concern to hire skilled men away from another. Therefore, we may as well face the facts and take the best available material and begin educating new men at once.

For the best solution to this problem, I would suggest hiring from 10 to 20 per cent more men than are required, because many of them will not make the grade. Those who do not show signs of qualifying should be eliminated as rapidly as this becomes apparent.

In selecting new men, we have found those most suitable for aircraft work are clean-cut inexperienced young men with the average common sense and fair education. In about a year, these men will be much more valuable than old experienced mechanics who have been trained in the ordinary machine or jobbing shops. The reason for this is that inexperienced young men are willing to learn, and will more nearly follow instructions, whereas, older experienced men oftentimes resent being told what to do. They feel that their knowledge of machine-shop work is sufficient and that they need no further schooling. Another extremely important phase of aircraft work is that of testing and accurately recording the results of tests. The best testing equipment and personnel available, and the best instruments and test equipment are none too good for testing some of the aircraft accessories now in use, and many improvements can still be made to the methods now employed.

Again, the fact should be stressed that good machinability of aircraft units starts in the engineering department, and that many excellent designs have fallen by the wayside because of extremely difficult machining operations, resulting in failures which were in no way the fault of the machining or the workman, but in design alone.

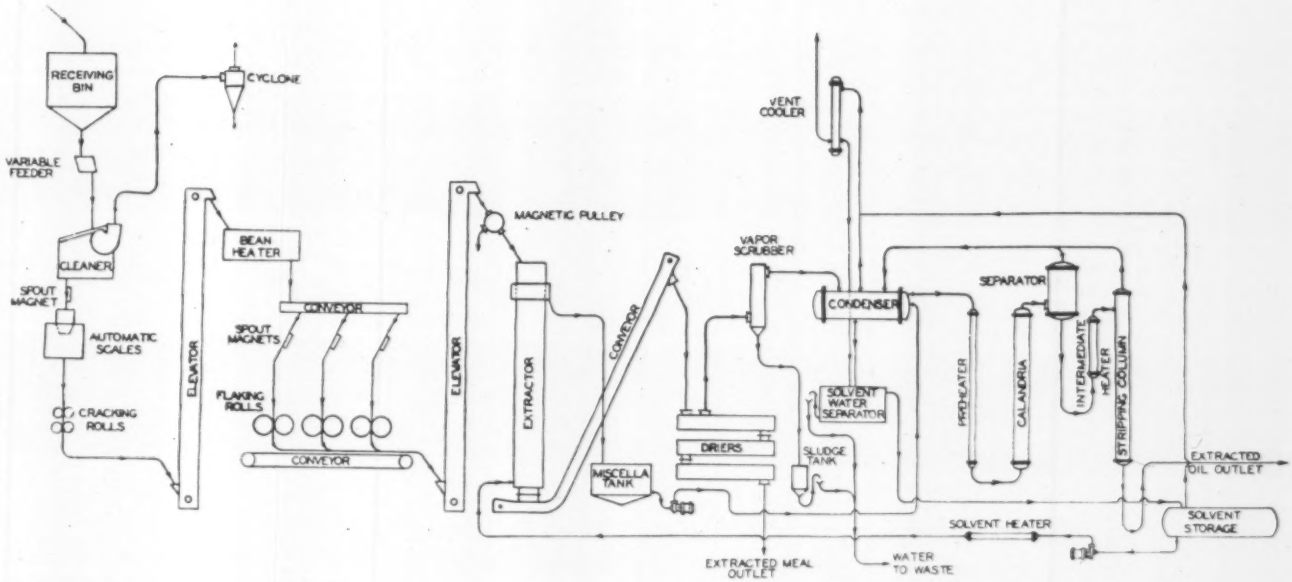

FIG. 1 DIAGRAMMATIC FLOW SHEET FOR CONTINUOUS SOLVENT-EXTRACTION PLANT

Continuous SOLVENT EXTRACTION *of* VEGETABLE OILS

By C. W. BILBE

ALLIS-CHALMERS MANUFACTURING COMPANY, MILWAUKEE, WIS.

THE fact that solvent extraction of oils is usually regarded as a chemical process may cause some persons to feel that the subject is out of place at a meeting of mechanical engineers. The author's experience in designing and building such plants, however, has led him to the belief that, given the proper chemical-engineering basic design, the success or failure of such a plant is to a considerable degree determined by the excellence of its mechanical conception and design. The problems of materials handling, mechanics, fluid flow, and heat transfer are many and varied. At the same time the mechanical engineer must be conversant with the basic chemistry involved and should have a working knowledge of the corrosion-resistant properties of the various materials of construction and where they can be used. These remarks probably apply with equal force to any of the process industries.

BRIEF HISTORY OF SOLVENT EXTRACTION

The history of solvent extraction in this country dates back to about the time of the War between the States. It is only recently that great strides have been made in this field. Indeed, the first large-scale continuous solvent-extraction plant did not appear in the United States until early in the last decade.

It is interesting and perhaps significant to note that this arrival of continuous solvent extraction as an established commercial fact coincided roughly with a leveling off in the total consumption of oils and fats. The total factory consumption of primary animal, vegetable, and marine fats and oils has remained at about 5,000,000,000 lb annually since 1930. Unless and until new uses are discovered or new avenues of consumption are opened it is therefore probable that the vegetable-oil processor will be selling in a buyer's market for an indefinite period or until export markets may be regained.

Since this first continuous solvent-extraction plant was built, less than nine years ago, six others are known to have been completed. All of these are located in the Middle West and are used chiefly in processing soybeans. Their aggregate capacity is about 1350 tons per day. Two others will probably go into service shortly, raising the daily capacity to about 1550 tons. Based on a 300-day operating year and assuming an 18 per cent yield, this plant is capable of processing 39 per cent of the factory consumption of soybean oil based on 1940 census figures. The usual vegetable-oil-extraction plant may operate on a much shorter schedule than 300 days per year, depending on availability of raw material.

It is thus evident that the soybean processors have already pointed the way toward modernization of facilities and consequent lower production cost and greater profit. While cotton-oil consumption has remained virtually stationary at about a billion and a half pounds per year in the last 30 years, soybean-oil consumption has increased from only 14 million pounds in 1930 to 432 million in 1940.

DIFFERENCES IN PRACTICE IN UNITED STATES AND ELSEWHERE

The growth of the solvent-extraction processing industry in this country has been paralleled by development work on the

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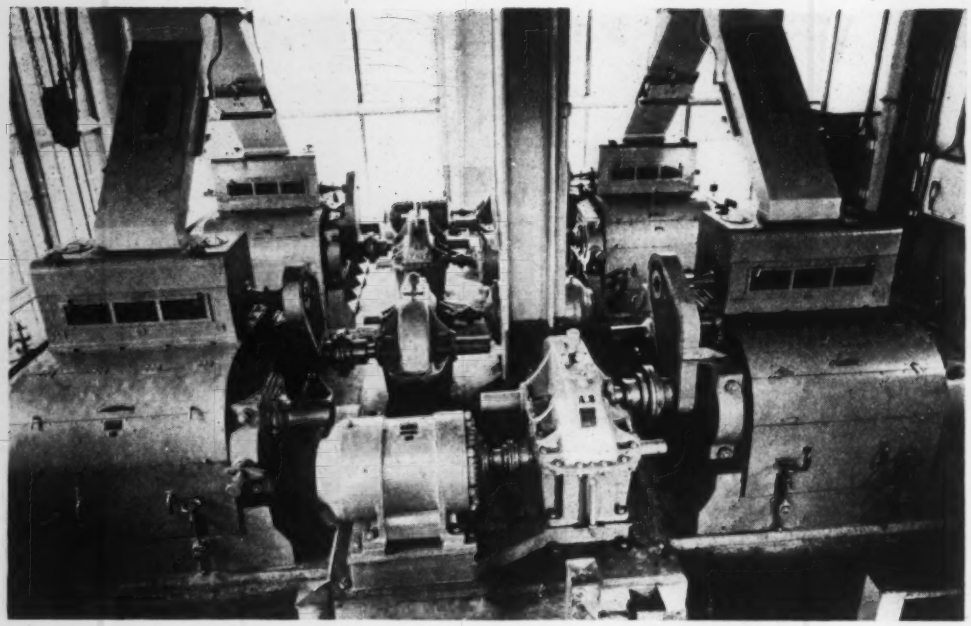


FLAKING ROLLS IN CORN-OIL EXTRACTION PLANT

part of process-machinery manufacturers to the extent that oilseed processors need no longer be dependent on foreign sources of supply for machinery.

American development has in some respects taken a radical departure from European methods and technique. This has probably resulted from the tendency of American processors to force machinery to the ultimate and to be impatient of shutdown delays for cleaning, servicing, and adjustment. The author does not know of any continuous extraction plant in this country that is not operated at greater than designed capacity. This is no doubt due to high labor and high machinery cost compared to European standards. Parenthetically, some operators of European equipment have found it advantageous to supplement it with American developments and refinements to enable them to increase production and to minimize shutdown time for cleaning.

One unique American development is the application of a spray-type scrubbing system to clean vapors from the driers for the protection of condensers and other apparatus in the vapor system against fouling. An equally important function of this apparatus is to keep protein material out of solvent-water separators. This protein material formerly found its way through the condensers and caused an emulsion in the separator. This emulsion between the solvent and water layer tended to accumulate until one or both of two undesirable things happened. It might go to the sewer with resulting solvent loss and increased hazard, or it might flow back to the solvent storage where excessive moisture pumped to the extractor would invariably give trouble. Former practice required frequent shutdown for cleaning out condensers and separator.

THE EXTRACTION PROCESS DESCRIBED

Reduced to its simplest terms a solvent extraction plant will consist of means to perform the following steps:

1 Mill feed to a suitable condition for extraction.

2 Extract or leach oil from the feed material by use of a suitable solvent.

3 Remove and recover solvent from extracted residue.

4 Separate and recover solvent from the solvent-oil mixture (miscella).

A representative flow sheet illustrating the arrangement of such a plant is shown in Fig. 1. It will be seen that this flow sheet comprises the four steps just mentioned plus a number of auxiliary and intermediate functions. In all but the four major steps such a flow sheet will be modified to suit the particular materials and conditions under consideration. Means of preparation and means of miscella or oil clarification in particular may be subject to wide variations.

Although European extraction equipment of the basket and of the U-tube types is giving a good account of itself in this country, the author's experience has led him to the belief that a vertical, compartment type of extractor will give the best all-around results. Generally speaking it is more "foolproof" and specifically less liable to choking and bridging as a result of minor variations in moisture content or size, shape, and condition of flakes.

Such an extractor is equipped with plates or disks properly spaced to prevent bridging. Openings in these disks permit the downward progress of flakes against the counterflow of solvent or miscella. Scrapers and a rotating central shaft regulate the downward velocity of flakes and provide the agitation so essential to good contact efficiency. Sustained performance records are available showing a ratio of 0.6 lb of solvent per 1 lb of material treated. This includes solvent saturation or "hold up" in extracted material going to driers.

Such an extractor is usually discharged from the bottom by means of a suitable conveyer to elevate the material a sufficient distance above the solvent level to permit adequate drainage before discharging to the driers. Both screw conveyers and special ones of the Redler type may be successfully adapted to this work. In the case of the latter its velocity will probably preclude the possibility of drainage back through the conveyer itself. This difficulty has been surmounted by draining solvent from the casing through a suitable screen. This solvent is then returned to the base of the extractor through some external channel either by gravity or by pumping.

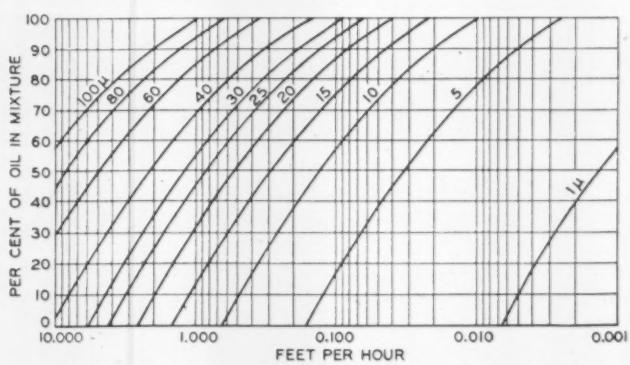


FIG. 2 SETTLING RATE OF SOYBEAN PARTICLES IN HEXANE-SOYBEAN-OIL SOLUTION AT 122 F

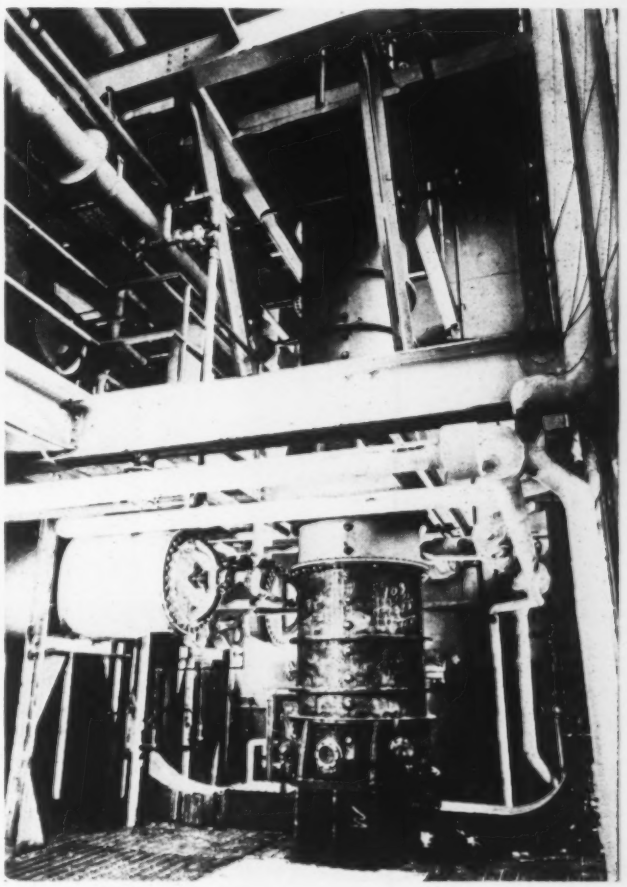
TABLE 1 PERFORMANCE CHARACTERISTICS OF 120-TON SOYBEAN EXTRACTION PLANT

Yield of oil (on No. 2 yellow beans average year), per cent	18
Solvent loss, gal per ton	2
Power required, kwhr per ton	20
Steam, lb per ton	1100
Water, gal per ton at 70 F	1600
Solvent in meal	Commercially free
Solvent in oil	Commercially free
Oil in extracted meal	1 per cent or less

TABLE 2 PROCESSING COST ANALYSIS FOR A 120-TON-PER-DAY SOLVENT EXTRACTION PLANT

	Item of expense	Investment, dollars	Yearly charges, dollars
1	Land, interest at 5 per cent	3000	150
2	Building, interest at 5 per cent	25600	1280
3	Building, depreciation at 5 per cent	.....	1280
4	Building, maintenance at 2 per cent	.....	512
5	Office, furnishings, interest at 5 per cent	3000	150
6	Office, furnishings, depreciation at 5 per cent	.....	150
7	Office, furnishings, maintenance at 4 per cent	.....	120
8	Machinery, interest at 5 per cent	120000	6000
9	Installation cost: piping, wiring, etc., at 5 per cent	24800	1240
10	Depreciation, 10 per cent of items 8 and 9	.....	14480
11	Maintenance, 0.8¢ per bushel (33 bushels per ton of soybeans)	.....	9600
12	Solvent inventory	1920	96
13	Taxes, $30 per $1000 on 70 per cent valuation of items 1, 2, 5, 8, 9, 12	.....	3750
14	Insurance, $20 per $1000 on 90 per cent valuation of items 2, 5, 8, 9, 12	.....	3160
15	Steam, 35¢ per 1000 lb	.....	13860
16	Water, 5¢ per 100 cu ft	.....	3850
17	Power, 1 1/3¢ per kwhr	.....	9576
18	Solvent loss, 12¢ per gal	.....	8640
19	Labor, 3 men per shift at 60¢ per hr	.....	12960
20	Superintendent	.....	3500
21	Preparation and extraction totals	178320	94354
22	Machinery for cooling, grinding, and sacking: interest at 5 per cent	8840	442
23	Installation of (22): interest at 5 per cent	3120	156
24	Depreciation, 10 per cent of items 22 and 23	.....	1196
25	Maintenance, 0.2¢ per bushel	.....	2400
26	Oil-storage tanks, 50,000-gal	3500	175
27	Oil-storage installation	875	44
28	Oil-storage depreciation, at 5 per cent, items 26 and 27	.....	219
29	Oil-storage maintenance, at 2 per cent	.....	88
30	Oil inventory 1 week's output at 5 per cent per lb	15120	756
31	Meal inventory 2 weeks' output at $25 per ton	33600	1680
32	Taxes, $30 per $1000 on 70 per cent valuation of items 22, 23, 26, 27, 30, 31	.....	1366
33	Insurance, $20 per $1,000 on 90 per cent valuation of items 22, 23, 26, 27, 30, 31	.....	1211
34	Power, 6 kwhr per ton at 1 1/3¢	.....	2873
35	Labor, 2 men, 1 shift per day at 60¢ per hr	.....	2880
36	Total meal and oil-handling cost	65055	15486
37	Processing cost per bushel for preparation and extraction, assuming operation at 120 tons or 4000 bushels per day for 300 days per year	.....	0.079
38	Processing cost per bushel for meal and oil handling	.....	0.013
39	Total processing cost per bushel	.....	0.092

Miscella is normally withdrawn from the top of the extractor through an annular screen. A tapered bar or "wedge wire" is, in the author's opinion, the most suitable screen to date. Such a screen can be designed to be largely self-cleaning but it can only be relied upon to retain particles of the order of 200 microns in size and over. However, the percentage of particles between 40 and 200 microns will be relatively small. The largest part of the fines carried by miscella will be less than 40 microns in size.



BASE OF EXTRACTION COLUMN SHOWING DISCHARGE CONVEYER

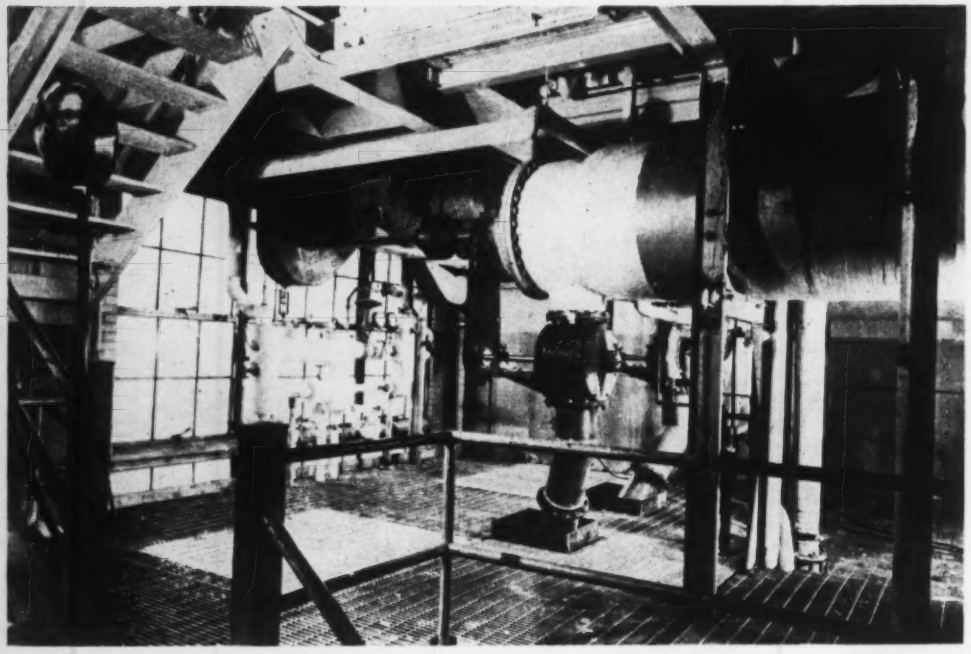
The problem of removing these minus-40-micron particles has been a serious one. A reversion to the old method of settling tanks has been tried in this country as a departure from the European practice of filtration through plate and frame filters. This apparently backward step was taken in an effort to reduce the hazard incident to opening and cleaning presses handling volatile solvents and to eliminate a labor-consuming step. Usually the American-built extraction plant must operate with a smaller personnel than is common in European practice.

Although clarification is theoretically possible by settling, it has not been a complete solution to the problem for practical reasons of size and time limitations. (See settling-rate curves, Fig. 2.) About 10 per cent of total entrained fines can be economically removed in a soybean extraction plant by settling. As it is good practice to have a small amount of miscella storage between extractor and distillation anyway, this settling can be accomplished here without appreciable added cost.

The remaining portion of the entrained solid "fines" can be safely and economically removed *after distillation*. It has been demonstrated by day-in-and-day-out operation of a large commercial plant that by using "stills" and associated equipment designed to handle miscella containing solids, it is possible to produce an oil of premium grade in all respects including color. This is probably not possible with the old type of "pot still" or any device that holds the oil at elevated temperature for an appreciable length of time.

TREATMENT OF OIL AFTER SOLVENT ELIMINATION

After solvent elimination the oil can then be treated for the removal of fines and phosphatides or other "foots" by cen-



DISCHARGE END OF DRIERS SHOWING DRIVES AND ROTARY OUTLET VALVES OF CORN-OIL EXTRACTION PLANT

trifugation or filtration or a combination of the two. If lecithin is to be recovered as a by-product, the oil will first be filtered hot to remove insoluble solids and then subjected to water washing to recover phosphatides.

If no lecithin is to be recovered it is probably most economical to complete the whole operation in one centrifugal treatment. The centrifuge sludge can be added to the feed if the extracted residue is to be sold for feed purposes. Here, of course, the solids will be sold at the meal value and the washing water will serve to bring up the feed moisture at the same time. The latter is usually necessary after an extraction process owing to dehydration incident to solvent removal. When the extracted residue is to be used as industrial protein it will be impractical to add the sludge. In this case it has some value as soap stock owing to its appreciable saponifiable fat content.

PERFORMANCE OF 120-TON SOYBEAN PLANT

A well-designed extraction plant for 120 tons of soybeans per day will have the performance characteristics noted in Table 1.

PROCESSING COSTS

In planning a new oil-extraction plant today, under existing market conditions the yield to be realized will probably be the deciding factor in selection of the method rather than cost of machinery. A method of predicting processing cost is illustrated in Table 2.

Cost of bean inventory and storage facilities is not included in the foregoing processing cost as storage is usually considered separately and normally will pay its own way.

Taking the differences in unit processing costs and yields into consideration, a comparison of solvent extraction versus mechanical expression processes will be about as shown in Table 3.

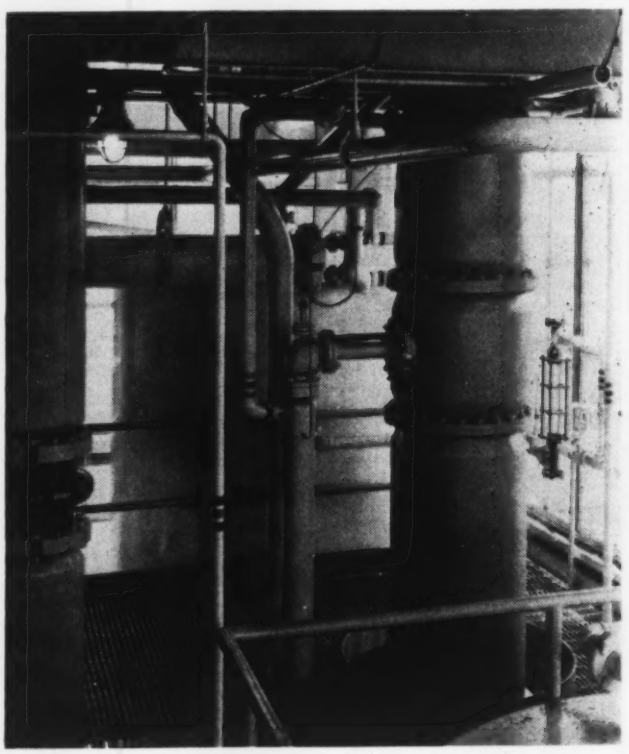
At the market prices in the example of Table 3 the solvent-extraction plant will yield a net return roughly two and one-half times that of the mechanical process.

TABLE 3 COMPARISON OF COSTS OF SOLVENT EXTRACTION AND MECHANICAL EXPRESSION PROCESSES

	Solvent extraction, dollars	Mechanical expression, dollars
Cost of beans, per pushel	0.90	0.90
Oil yield, pounds per bushel	10.8	8.4
Value of oil recovered per bushel at 5¢ per lb	0.54	0.42
Meal yield, lb per bushel	48	50.4
Value of meal recovered per bushel at $25 per ton	0.60	0.63
Total value of products	1.14	1.05
Gross margin per bushel	0.24	0.15
Processing cost per bushel	0.092	0.085
Net profit per bushel	0.158	0.065

CONCLUSION

Although the scope of this paper has been largely limited to a discussion of soybean processing, solvent-extraction methods are by no means limited to this field. In fact corn germ, flax-seed, and distillers spent grain have already been processed on a commercial scale in continuous solvent-extraction plants and a further extension into the realms of cottonseed, peanuts, copra, tung nuts, and other products probably awaits only a wider and better understanding of the operating economies to be gained.



PARTIAL VIEW OF SOLVENT-RECOVERY APPARATUS IN CORN-OIL EXTRACTION PLANT

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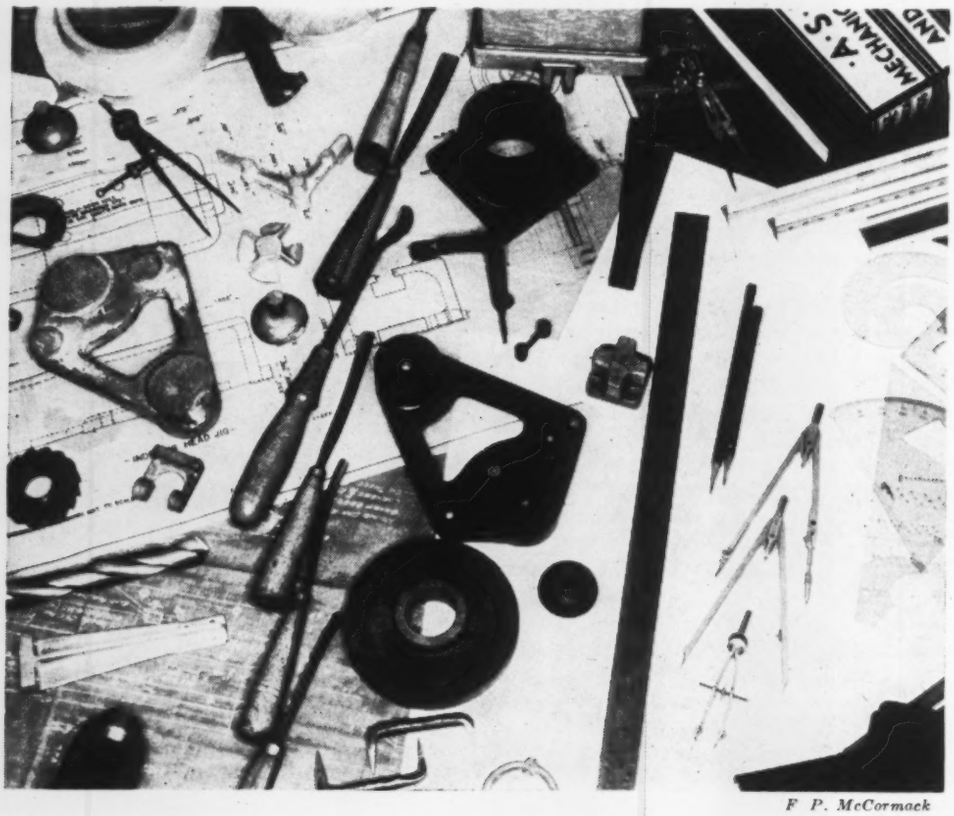


F. P. McCormack

Side Lights on History of PSYCHROMETRY

By DAVID DROPKIN

CORNELL UNIVERSITY ENGINEERING EXPERIMENT STATION, ITHACA, N. Y.

RELATIVE humidities of the air may be measured by the absorption, the dew-point, or the psychrometric method. The last-named method is the one commonly used at the present time. It employs a psychrometer which is an instrument consisting of a dry-bulb thermometer and a wet-bulb thermometer. The history of the dry-bulb thermometer is frequently discussed. On the other hand, the early histories of the wet-bulb thermometer and the psychrometric formula are not so readily available. It is the author's object to give a sketchy account of some of the high lights involved in the early development of the psychrometer and the psychrometric formula.

The earliest use of the wet-bulb thermometer was made by Baumé in 1758, and by de Saussure in 1787, for the purpose of measuring the "evaporative power" of air. They called this instrument the "evaporameter," and de Saussure employed it in the following manner: " . . . . for ascertaining the temperature of the air he used a thermometer with a fine bulb . . . . the latter form being converted into an evaporameter by inserting its bulb into a piece of wet sponge and making it revolve in a circle of known radius at a known rate."

In 1792 an ingenious philosopher, Dr. James Hutton, of Edinburgh, performed what was then called a "curious experiment." "He dipped a thermometer in water, both being previously brought to the general temperature; and then, exposing the wet bulb to a current of air, he marked how many degrees the mercury sank in the tube; and he estimated the dryness of the air by the quantity of the depression" (1, 2).[1] This was the first known attempt to measure humidity of the air by what is now known as the "psychrometric method." For want of knowledge of laws pertaining to the phenomenon mentioned, no complete and accurate account of Dr. Hutton's experiment was given until some 30 years later.

In 1822 J. Ivory made an analysis of Hutton's experiment and derived some interesting algebraic relations. In his analysis, he reasoned: "In perfectly still air it is known that evaporation goes on very slowly; and this circumstance may make it difficult to discern when the action between the air and the bulb has come to an invariable state. Some agitation of the instrument, or some motion in the air, seems to be proper, whether to hasten the permanent degree of cold, or to ascertain that it has actually taken place.

"On the other hand, every portion of air must take up some definite time in parting with its heat and absorbing its share of vapor; and if we suppose a circulation so brisk as to displace the air from the thermometer in half that time, it is plain that it would be only half-saturated with moisture by its contact with the wet bulb; in which case the experiment would be unsuccessful. This, however, is only an extreme case, which it would be easy to guard against were the effect well ascertained by experiment."

Ivory also stated that the other factors, which may give a false reading of the wet bulb, are the thermal conductivity through the thermometer stem and some outside source of heat, i.e., heat other than that from the flowing air. These, however, he thought were not serious for practical purposes.

Although some of his reasoning does not agree with the present-day theories of the wet-bulb hygrometer, it is interesting to note that many of his equations are yet in use. For example he reasoned that

$$\left[240\,W\left(\frac{a}{1+m\tau}\right)\left(\frac{b-x}{30}\right)+\left(5\,W\frac{xs}{1+m\tau}\right)\right]\frac{\delta\tau}{\lambda}$$

= weight of water

evaporated due to the heat extracted from the air-vapor mixture when its temperature is lowered from the dry bulb to the wet bulb.

In this equation

$\frac{240\,W}{1+m\tau}\times\frac{b-x}{30}$ = weight of 1 cu ft of dry air

a = specific heat of air

$\frac{5\,Wx}{1+m\tau}$ = weight of 1 cu ft of vapor at temperature τ and pressure x

s = specific heat of vapor

$\delta\tau$ = temperature difference between dry-bulb temperature and wet-bulb temperature

λ = latent heat of vaporization

Translating the equation from volume basis to weight basis and putting the terms in familiar symbols, we have

$$(\rho C_{pa}+WC_{ps})\frac{(t-t')}{r'}=(W'-W)$$

in which

ρ = weight of 1 cu ft of dry air

C_{pa} = specific heat of dry air

W = weight of 1 cu ft of vapor at temperature t and its partial pressure

C_{ps} = specific heat of vapor

t = dry-bulb temperature

t' = wet-bulb temperature

r' = latent heat of vaporization at wet-bulb temperature

$(W'-W)$ = water evaporated by heat extracted from air-vapor mixture by its drop from temperature t to temperature t'

Putting this equation on the basis of weight of vapor per pound of dry air, it becomes

$$(C_{pa}+C_{ps}w)(t-t')=r'(w'-w)$$

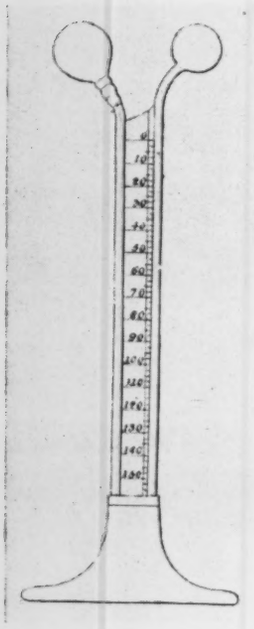
This equation is used at the present time for the derivation of most psychrometric charts.

[1] Numbers in parentheses refer to the Bibliography at the end of the paper, page 376.

LESLIE'S DIFFERENTIAL THERMOMETER

While experimenting on the evaporation of ice, during the winter of 1794–1795, Sir John Leslie was led to the construction of a differential thermometer. This instrument he used as a wet-bulb hygrometer to determine relative humidities.

His description of the instrument (3) is as follows: "At first, he employed it merely as a hygrometer, the one ball being always 'naked' and the other covered with cambric, wetted as often as occasion required. These balls were about an inch and a half in diameter, and blown to the ends of the same tube, one of them having a projecting point or aperture which was sealed, after the branches had been bent, and a portion of colored oil introduced."



HYGROMETER DEVELOPED BY LESLIE IN 1794

Leslie's hygrometer was the first of that type to be accepted as a reliable instrument. Although it was Hutton who conceived the idea of using a wet-bulb thermometer to determine the relative humidity of the air, credit should be given to Leslie for constructing and popularizing the moist-bulb hygrometer.

Ivory's explanation of heat transfers taking place at the wet-bulb thermometer stimulated interest in the temperature of evaporation. In 1825, E. F. August (4) published a treatise on the wet-bulb hygrometer. He was fortunate in having in his possession the theories proposed and the instruments used by Dalton, Hutton, Leslie, Ivory, and Daniell. Not only did he elaborate on Ivory's theory, but he also performed extensive experimental work (5) to determine the relationships existing between the dry-bulb and wet-bulb temperatures, and the relative humidities in the air. He used Daniell's hygrometer (6), as a reference instrument, in his derivation of hygrometric equations. (It should be pointed out that the so-called Daniell hygrometer was in reality a dew-point apparatus.)

It is of historical interest to note that it was August who proposed the name "psychrometer" to the wet-bulb hygrometer. He probably chose this name because "psychro," taken from the Greek, means cold, while the suffix "meter" means an instrument for measuring. That is, the word "psychrometer," when translated, is an instrument for measuring cold, or probably as August thought of it, an instrument for measuring the cooling effect produced by the evaporation of moisture from the wet-bulb thermometer.

Another proponent of the Ivory-August theory was J. Apjohn. In 1834–1835, two papers were presented by him (7) dealing with the subject of the moist-bulb hygrometer. He proposed an equation for determination of vapor pressures at dew-point temperatures from the wet- and dry-bulb temperature readings. This equation he substantiated with experimental data.

The Ivory-August-Apjohn theory of the wet-bulb thermometer is often referred to as the convectional theory. In it the assumption is made that the resistance to the heat and vapor transfers through the laminar film at the wet bulb is negligible. This, of course, would be true at infinite air velocities. The psychrometric relationship for this theory, when radiation is neglected, is expressed by the equation

$$\frac{e' - e}{P(t - t')} = \frac{M_a C_p}{M_v r'}$$

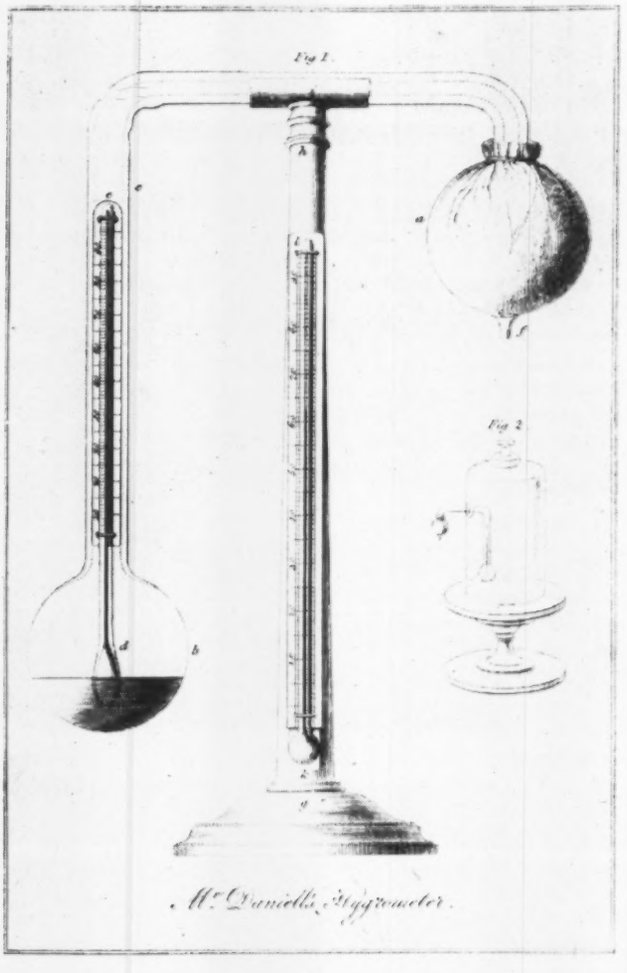
in which

e' = vapor pressure at wet-bulb temperature
e = partial vapor pressure in air-vapor mixture
P = total pressure of mixture
t = dry-bulb temperature of mixture
t' = wet-bulb temperature of mixture
M_a = equivalent molecular weight of air
C_p = humid specific heat of mixture
M_v = molecular weight of vapor
r' = latent heat of vaporization at wet-bulb temperature

An entirely different approach to the derivation of a psychrometric formula was made by Clerk Maxwell (8) in 1877. He reasoned that the theory of the wet-bulb thermometer should be attacked from the molecular point of view. According to him, heat is supplied to the wet bulb by radiation and conduction and is abstracted by evaporation which is a diffusional process. While his approach to the problem is clever and interesting, the conditions imposed are ideal and never realized in practice. For that reason, the diffusional theory never became popular.

Maxwell's equation, when radiation is neglected (9), takes the form

(Continued on page 376)



DANIELL'S HYGROMETER; IN REALITY A DEW-POINT APPARATUS

THE FALSE GOD, SELFISH SECURITY

By A. R. STEVENSON, JR.

GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y.

WHILE I was trying to think of a subject for this talk one of my friends suggested that all the young men just about to leave college want to know about the future.

The difficulty of making any predictions is illustrated by the following quotation[1] used by the King of England in his New Year's message a year ago:

> I said to a man who stood at the gate of the year, "Give me a light that I may tread safely into the unknown," and he replied, "Go out into the darkness and put your hand into the hand of God. That shall be to you better than a light and safer than a known way!"

We hear a good many shallow comments that we should direct our attention to the present and the future and forget all about the past. Some people say, "Let the dead past bury the dead."

I do not know how one is going to get any idea of what the future may be without studying the past. You technically trained engineers know that you cannot extrapolate a point. The only hope of extrapolating is to have a curve leading up to the point, and even then it is quite a gamble unless you know something about the laws which the curve is following.

This is one of the reasons why so much has been said recently about the broadening of the education of engineers. If an engineer knows nothing except technical things, how can he have any idea as to what the future may be? It is obvious that many nontechnical things have a tremendous bearing on the future of engineers. Two major examples are the depression, which is just behind us, and the war, which is now warping all our lives. Already many are beginning to be worried about the depression which may follow it. In other words, an engineering career can be completely upset by things outside the realm of engineering. If you are going to have any opinion as to where you will go from here, it is obvious that you should have studied enough history to have a perspective from which to extrapolate your present position. As I have suggested, in addition to having a knowledge of the shape of the curve up to a certain point, it is also advisable to have some knowledge of the fundamental principles governing the curve.

Technically, we believe in fundamental principles today; but, unfortunately, many people ethically, morally, and spiritually have thrown overboard any belief in fundamental principles.[2]

The Bible is one of the world's greatest books, partly because it interprets history in the light of certain fundamental principles over a period of several thousands of years. Part of the decay of the world is due to a lack of religion. People ask: "Why did France collapse so easily?" Part of the trouble is that many of the leaders in France have been atheistic without correct fundamental principles, for several generations. Perhaps it is unfair to criticize France too much because without the ocean to give us time we might have collapsed in the same way before a sudden assault.

But since religion is such a controversial subject let us step outside the realm of religion and see if there are any fundamentally recognized principles.[3]

The history of philosophy teaches that there are certain things which have to be by-products. They are destroyed when one goes directly after them. A classic example is happiness. Almost every really educated man will admit that happiness has to be a by-product; one destroys it when one reaches for it.

In his baccalaureate address entitled, "The Perils of Security," which was given in June, 1937, Dr. Harold W. Dodds, president of Princeton, pointed out that security must also be a by-product. This is not so generally recognized, but it seems obvious when attention is called to it. The following is a quotation taken from the Bible[4] which shows that those who take risks will gain more than those who are fearful and try to play safe:

> For the kingdom of Heaven is as a man travelling into a far country, who called his own servants, and delivered unto them his goods.
>
> And unto one he gave five talents, to another two, and to another one; to every man according to his several ability . . . . . .
>
> Then he that had received the five talents went and traded with the same, and made them other five talents.
>
> And likewise he that had received two, he also gained other two.
>
> But he that had received one went and digged in the earth, and hid his Lord's money.

And thus, the man who buried his talent in the ground "to keep it safe" had it taken away from him, while the man who risked his talents in the business world gained "other five talents."

My personal belief is that one of the greatest causes of the depression of 1932 which we have just been through was an almost universal worship of the false god, security, which had grown up not only in this country, but all over the world.

When people turn from correct fundamental principles and worship a false god, security, they get into trouble just as the

An address delivered to the senior class, Cornell University, Jan. 17, 1941.

[1] Written by Miss M. Louise Haskins and used in a world-wide radio address made by His Majesty, King George VI, from Sandringham, England, Christmas Day, 1939.

[2] C. E. Wilson, President of the General Electric Company in a speech made at the A.I.E.E. Convention in Philadelphia, Pa., on January 29, 1941, said:

"Here I submit, in all seriousness, as a first step—Prayer and the wholehearted Practice of the Golden Rule—and, happily, that fact is gaining greater force with each passing day as a bedeviled and bewildered world seeks the solace and divine inspiration from the source of all righteousness and all human rights."

[3] The following is taken from the *New York Herald Tribune*, February 28, 1941, entitled "On the Record," by Dorothy Thompson:

This is what makes it so easy for them to be liberals one moment and progressives the next, and to sail from either point into an apologia for Fascism or for Communism. The end of it all is Nihilism. They don't know what they believe in, and, indeed, they are encouraged to think that to believe in anything at all is somehow "narrow-minded," as though the mind were something indiscriminately open to every plausible idea and was not an organ for constant precise selection choice, association, synthesis. . . .

Our students admire Lincoln because they have been taught that he sought to make a larger and more social democracy, which is correct, but they do not drink at the same spring from which Lincoln drank—namely the Bible, from the wisdom of the great prophets and the inspired Gospels.

[4] New Testament, The Gospel According to St. Matthew, Chapter 25.

children of Israel did when they turned from Jehovah and worshiped false gods, such as Moloch and Baal.

The depression started when everyone was worshiping material prosperity. There was "a new high level of prices." We said to ourselves, "Soul, thou hast much goods laid up for many years; take thine ease, eat, drink, and be merry."[5]

And right at that moment our prosperity started to disappear.

Then, as prices began to fall, everyone selfishly began to try to save his own skin, seeking personal security at the expense of the whole group.

Everyone that retrenched more than was necessary caused others to economize still further. A generation ago a depression in New York might be over before the news reached San Francisco. But today bad news travels fast on our splendid communication systems and the result in 1932 was that our whole country and, in fact, the whole world, talked itself into a simultaneous depression. As matters got worse and worse, the experts kept giving people advice not to buy anything or do anything until after the depression had turned the corner. It is a wonder to me that it ever did turn the corner. We talked so much and listened to so much advice from the experts that we led ourselves into the depths, and part of it was due to the worship of the false god, security.

There were a few outstanding exceptions. The Pennsylvania Railroad put through its huge electrification plan, giving business and employment to thousands during the depression. The result is that the railroad got this work done at bargain prices and is now in good shape to handle efficiently an increase in business.

The General Electric Company spent millions of dollars in the Engineering Department keeping engineers, draftsmen, and toolmakers busy on development work. Almost all the apparatus of the company was radically redesigned during the five-year period, and a new department, the Air Conditioning Department, was created.

There probably were many other individuals and companies who contributed in this way. But in general there was no patriotic fervor which caused people to risk their all in a joint effort to stem the tide. Instead, we followed after many false gods trying to increase prosperity by destroying goods and artificially reducing production. These schemes did about as much good as some black-magic formula of a medicine man might have done.

As much unselfish patriotism is needed to stem a depression as to fight a war.

Some years ago I saw a motion-picture film, called "Lloyds of London," which portrayed the patriotic action of the marine-insurance brokers in England during the Napoleonic war in keeping the British merchant marine insured and on the seas even at dire financial risk to themselves.

One of my friends, who was vice-president and general manager of a munition concern during the last World War, told me of a director's meeting at which the directors discussed a contract which looked like quite a hazardous undertaking. One of the directors said, "The Government needs these shells, and I vote that we take this contract even though we go broke." It turned out that they made a great deal of money on the contract. The point that I am making is that success very often comes to the person or concern that does the best thing possible to make its contribution rather than to the one that asks selfishly, "What shall I get out of it?"

In a war, patriotic soldiers do not try to save themselves at the expense of the group. On the contrary, it is only by being willing to risk being killed that the soldiers win a battle.

The field of international politics offers another example. The democratic nations of Europe were anxious for peace and security. They tried to play it safe to the point where they have been nearly overrun. It was only when England got Churchill at the helm—a man who threw security to the winds and really started to put up a fight for civilization—that hope began to appear on the horizon. There seem to be some people in our own country today who think that we can play safe and selfishly protect our own security. If their advice were followed to the limit, so that we gave England no help at all, our turn would someday come and we should be overwhelmed. Our only hope is to help England generously and by helping England we shall help ourselves.

Of course, this matter of mobilizing our resources for our national defense in the quickest possible manner is of the greatest importance today. I think that probably you are all in sympathy with this and that there is no use of my discussing this matter further.

At a recent meeting of The American Society of Mechanical Engineers in New York City, William L. Batt, president of the SKF Ball Bearing Company and assistant to E. R. Stettinius, Commissioner of Industrial Materials Department of the National Defense Advisory Commission, pointed out that we ought to be looking much farther into the future in the present emergency.[6] He said that many nations have had mobilization plans which were outlined with steps to be taken on "M" day, when war is declared, whereas probably no nation has ever made demobilization plans for "P" day, when peace is declared.

It is much easier to keep a machine running than to start it again after it has stopped, and it is much easier to keep the wheels of prosperity turning than to start them after a depression. It is obvious to all who have thought about it that we should have a plan ready to "beat swords into ploughshares" the instant peace is declared. We must devise new things and be prepared to put new developments into the shop instantly to utilize the machinery and keep labor busy when the armament contracts are canceled. If there is any delay in doing this, millions of people will be unemployed and will again lose their purchasing power, and it will be very difficult to get started again.

During a mobilization for national defense there are many people who will unselfishly forget themselves and throw their all into the undertaking.

The real question is, "Can the majority of us cease following the false god of security and patriotically be willing to risk our all on demobilization day in making sure that the wheels of industry keep turning?" Of course it would be hopeless for any one man or any one company to stem the tide alone, just as it would be suicide for one soldier to march forward by himself if he did not have confidence that his comrades were willing to march alongside, taking their share of the risks. The battle is only won when there is mutual confidence and cooperation between the individual soldiers.

If, on demobilization day, each business leader tries to be selfishly cleverer than the next and tries to beat all his neighbors in cutting expenses in order to prepare for the worst depression in history, there is no doubt that the worst depression in history will follow.

On the other hand, perhaps such a spirit can be developed that business leaders will say: "This is an even more serious emergency than any war, and it requires the same sort of patriotism. It is now or never as to whether the democratic system can be made to work. We must be prepared to risk our all in order to keep the wheels of industry turning." If this spirit can be engendered, and if the engineers have enough imagination to think up new things to manufacture for peace-

[5] Luke, 12: 20.

[6] "Through a Glass, Darkly," MECHANICAL ENGINEERING, January, 1941, pp. 5–8.

TABLE 1 NUMBER OF HOURS' WORK REQUIRED TO PURCHASE

Country	Food	Incandescent lamp	One kw of electricity
1	4.9	1.8	0.4
2	7.2	2.5	0.5
3	4.25	1.3	0.3
4	6.1	1.2	0.3
5	5.0	1.4	0.3
6	4.6	2.4	0.2
7	6.2	3.4	0.5
8	7.3	2.0	0.72
United States	1.7	0.2	0.06

TABLE 2 NUMBER OF MONTHS' WORK REQUIRED TO PURCHASE

Country	One year's rent	Automobile	Electric refrigerator	Radio
1	2.1	18.0	2.5	0.9
2	2.6	20.2	2.9	0.5
3	2.8	8.5	2.4	0.5
4	2.2	12.1	2.4	0.8
5	3.2	10.5	2.7	0.4
6	3.9	14.8	3.0	1.5
7	3.2	24.0	7.3	0.8
8	2.5	22.5	6.3	0.9
United States	2.2	4.5	1.0	0.2

These tables have been copied from "Standards of Living," by Gerard Swope, the *Atlantic Monthly*, March, 1938, vol. 161, no. 3.

time trade, there is a good chance that the bogey of depression may be overcome.[7,8]

Perhaps we had better remind ourselves of some of the advantages of our free democracy.

The recent depression should not blind us to the marvelous economic advancement which has been achieved.

In his presidential address, "Engineering and Social Progress," before the Society for the Promotion of Engineering Education,[9] in June, 1939, President Karl T. Compton of the Massachusetts Institute of Technology said: "We know, for example, that the people of the United States are served by the energy equivalent of one hundred slaves working twelve hours a day for each man, woman, and child, and that this achievement in energy production has been attained with amazing rapidity. At the turn of the century the power used in this country was approximately equivalent to two man power per capita."

The material progress has been faster here than in any other country. Let us see what the comparison was, just prior to the war.

Table 1 shows the number of hours' work required to purchase food, electricity, or an incandescent lamp in various countries of the world.

Table 2 shows the number of months' work necessary to purchase a year's rent, and an electric refrigerator, an automobile, or a radio.

One might say that perhaps the prosperity of America has been due to natural resources rather than to freedom and the adventurous pioneering spirit. The answer is: "Look at Switzerland which has no natural resources or colonies and which before the present war was one of the happiest and richest countries per inhabitant in the world and remember that Switzerland is the freest and oldest democracy in the world."[10]

"The Autobiography of an Engineer," which was recently published by The American Society of Mechanical Engineers, illustrates the freedom which has been enjoyed in our democratic country. When Mr. Emmet was only a young fifteen-dollar-a-week construction man, he was sent to Allegheny, Pa., to install a trolley line. He realized from previous experience that there would be many motors burned out due to the splashing of water on the poor insulation. He decided to tear the motors all apart and completely rewind them according to a new design of his own, which incidentally included varnished cambric insulation, and which later became almost universal. He took this responsibility knowing "that Nelson and others did not always obey orders and that some disobedience was all right for those who could get away with it successfully."[11]

It is unlikely that a young man would have taken these risks under a dictatorial or bureaucratic régime. The book is full of illustrations indicating Mr. Emmet's initiative and willingness to take risks in order to accomplish worth-while projects. In his later life he was not content to sit back and enjoy the fruits of his labor but undertook the most difficult project of all, the development of the mercury turbine.

It has been the endeavor of this paper to point out that individuals, companies, and nations, should not make security their chief aim. Dictatorships probably result from an exaggerated longing for security and a desire on the part of the people to shift the responsibility for their security to a dictator. For this fancied security they are willing to barter away their freedom. A beneficent dictator would undoubtedly be paternalistic, the people would be treated like children and would not develop individual responsibility. A dictatorial or a bureaucratic control gradually destroys both freedom and initiative.

It is thus evident that if one desires to turn from the false god, security, and follow an adventurous life, the logical form of government is a free democracy where individual initiative is not only free to develop but also encouraged to the fullest.

Oliver Wendell Holmes once said, "The longing for certainty and repose is in every human mind. But certainty is generally illusion and repose is not the destiny of man."[12]

[7] From *Barron's*, The National Financial Weekly, January 20, 1941, "Where Do We Go From Here?" by Walter Von Tresckow.

"There is also no exception to the fact that those nations grow and prosper most where private employment is at a peak and absorbs most of the workers. No economic group has grown or lasted under any other set of circumstances.

"Therefore, the employers must organize the work of the community and provide the work for the individual. It is their reason for existence. Failure to do so will bring taxation not only of their wealth but also of all wealth, to make up for the lack of work. In the end they will be superseded or removed from their function by the Government or by violence. The prior lien of the necessity to live will not tolerate profits and wealth in the employing group or anywhere else when employers are not performing their main function."

[8] C. E. Wilson, the president of the General Electric Company in a speech made at the A.I.E.E. Convention in Philadelphia, Pa., on January 29, 1941, said:

"Then, indeed, at this time when our future economic security is at stake, we must call upon all of our vision and imagination—upon all of our resources—upon all of our ingenuity—and, above all, upon the same deep sense of service that now motivates us, as we move forward in providing the materials for our physical security—to the end that all employables will be kept employed—and that the preponderant majority will find employment on the pay rolls of the Private Enterprise system."

[9] *The Journal of Engineering Education*, September, 1939.

[10] The Economic Almanac for 1940 published by the National Industrial Conference Board shows, on page 301, the wealth of various countries.

Year	Country	Monetary unit	Wealth in millions	Population in millions	Wealth per capita
1932	Switzerland	Franc	62,450	4.066	15,300 F
1932	United States	Dollars	$307,699	124.95	$ 2462

At that time the rate of exchange was slightly over 3 francs to the dollar. "Caution should be exercised in making international comparisons because in some cases total wealth consists of only private wealth while in others it includes public wealth. In addition there are variations in the methods of compilation."

[11] "An Autobiography of an Engineer," by William LeRoy Emmet, pages 81 and 82.

[12] Quoted from an address by Philip D. Reed, Chairman of the Board of the General Electric Company, at a dinner at Milwaukee on February 27, 1940, entitled "American Free Enterprise and the Future." Printed by General Electric pamphlet GED—851.

ECONOMIC MOBILIZATION

By LEONID HURWICZ

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

BILLIONS are being voted and spent for defense. Men and resources, previously either idle or employed elsewhere, are paid with these billions to produce guns, airplanes, and other vital war supplies. This gigantic expansion in armaments output cannot fail to have far-reaching effects on all sectors of our economy. And yet, although the country has been warned that heavy sacrifices will be inevitable, the general public does not seem to take much interest in the economic problems created by the national-defense effort.

This attitude is not difficult to interpret. So far the armaments expenditure has meant fuller employment, greater purchasing power, in brief—recovery. And, unfortunately, the general interest in the economic problems seems to be confined to depressions and crises. . .

It should be realized, however, that the present period is of decisive importance for framing of future economic policies. For, if hasty work and unstable structures are to be avoided in the future, the solid foundations must be laid now. Small errors of construction can still be easily remedied; but, if they are overlooked now, their existence may later give rise to unexpected difficulties and additional expenditures of considerable magnitude.

Unlike the public, the economist is already "worrying" about those seemingly distant troubles. Articles, books, and pamphlets are being published. War finance, price control, civilian mobilization, and related subjects are being discussed. Two such pamphlets have been chosen for this review.[1] Both by distinguished economists, these pamphlets achieve admirable clarity of exposition without unnecessary oversimplification of the problems discussed. The technical economic jargon is scrupulously avoided, but readers familiar with the recent trends in economic thought will undoubtedly notice that the lucidity of analysis is often due to certain famous controversies which, after a period of general confusion, have brought us to . . . surprisingly simple and common-sense conclusions.

The fundamental question can be briefly stated as follows: What economic policies will yield maximum efficiency in the production of armaments, while minimizing the social cost of the national-defense effort? By "efficiency" is meant speed as well as volume of output. The social cost is to be calculated on a long-run basis, so as to include even a postwar slump in so far as attributable to wartime economic policies.

The magnitude of the social cost obviously depends on whether and to what extent the output of armaments can be expanded without diverting the employed resources from their present peacetime uses. As is well known, some industries are already experiencing considerable difficulties in procuring certain types of skilled labor and machinery. On the other hand, the aggregate unemployment figures are still very high and so is the percentage of idle equipment. However, as the general level of employment rises, shortages and "bottlenecks" are likely to develop in other branches of production. Hence, as time goes on, it will be progressively more difficult to expand the armaments output without diverting resources now used to satisfy civilian demand.

In the initial stages of armaments expansion, as Professor Lange points out, we can have both "guns *and* butter." "We can have a large production for national defense merely by drawing on our pool of idle resources" (p. 12). In fact, Professor Lange goes on, since a higher level of employment stimulates the demand for consumption goods, we may reach the paradoxical result—armaments expenditure will have raised the national real income.

It is interesting to note that Professor Lange's statement, which not so long ago would have been regarded as an economic "heresy," is nowadays hardly controversial among the economists. Professor Moulton, for instance, says that "in the first stage of the preparedness program an appreciable expansion of consumer income is possible without handicapping the defense program . . . curtailment of the production of consumer goods should not be made prematurely—for that would involve needless loss of consumer income and waste of resources" (p. 7).

However, as Professor Moulton and Professor Lange both agree, sooner or later it will become imperative to transfer resources from peacetime uses to the production of war supplies. For, clearly, shortages of specified commodities or special types of labor are not relieved by surpluses in other branches of production.

As soon as the "second stage" (severe shortages of labor and goods) is reached, the danger of inflation becomes imminent. Unless private demand is curtailed by taxation or other methods, the government will have to outbid the public, since both private and governmental demand can no longer be satisfied at the existing (relatively low) level of prices.

Both Professor Lange and Professor Moulton regard inflation as the most objectionable method of war finance, because inflation dislocates the economic structure of the country and is "the most potent source of industrial strife and class conflict." However, there seems to be a definite difference of views between the two authors as to what will cause the inflation.

Professor Moulton, for example, links the danger of inflation to the budget deficit, not as the only, but a very important, causal factor. "If the views of those who believe in high taxes and in rigid economy with respect to nonmilitary outlays are adopted, this important source of price inflation will be largely, if not wholly, eliminated. If those who oppose any increase in taxes on the masses and who believe that a continuous expansion of the public debt is not only unavoidable but economically desirable succeed in having their views accepted, the risk of a general inflation of prices will undoubtedly be greatly increased" (pp. 23–24).

Now it is certainly true that *if* high taxes and reduction in nonmilitary expenditure were the only means of curtailing the demand competing with the needs of the military machine, a budget deficit would inevitably imply a price inflation. More-

[1] "Economic Mobilization," by H. S. Bloch (Financial Aspects), Oscar Lange (Economic Aspects), F. H. Harbison (Industrial and Labor Aspects), and H. G. Lewis (The Outlook). Introduction by Prof. Paul H. Douglas. Published by the American Council on Public Affairs, Washington, D. C., 1940.

"Fundamental Issues in National Defense," by H. G. Moulton. Published by the Brookings Institution, Washington, D. C., 1941.

One of a series of reviews of current economic literature affecting engineering, prepared by members of the department of economics and social science, the Massachusetts Institute of Technology, at the request of the Management Division of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Opinions expressed are those of the reviewer.

over, the budget deficit may be regarded as undesirable even if it does not imply inflation. In fact, Dr. Bloch states that "when full employment is reached, income or capital taxation are the only *socially desirable* ways of financing which would prevent inflationary effects" (p. 8, italics are reviewer's). But, even when full employment has been reached, the budget deficit will not cause a general rise in prices, *unless* it is accompanied by expansion of effective demand. "Noninflationary borrowing is best epitomized by the slogan 'save and buy' during a government loan campaign, while inflationary borrowing is the inevitable result of 'borrow and buy' " (Dan T. Smith in the February issue of the *American Economic Review*, p. 91)

Thus, while Professor Moulton seems to regard every budget deficit as an unmistakable sign of inflationary borrowing, the authors of the "Economic Mobilization" advocate taxation as against borrowing, even though borrowing need not necessarily be inflationary. It is evident that the difference, though theoretically important, does not affect the practical conclusions. Both pamphlets reject the inflationary solution and advocate taxation, although there might be slight differences of opinion with respect to timing of the taxes.

One danger, pointed out by Professor Moulton, is that the inflationary price rise may begin much before general full employment has been reached, namely, as soon as the first bottlenecks appear. The question is, however, whether the remedies suitable for preventing a *general* price rise are also desirable in case of *sectional* shortages and bottlenecks. The answer is obviously in the negative. There is certainly no reason to increase the burden of taxation because there is a shortage of shoes in the market! Evidently, the "market mechanism" (i.e., price rise) would suffice to bring about readjustment. However, since (in the case of consumption goods) this involves social inequities, rationing may be preferable, although "from the purely economic point of view restriction in demand through a rise in price or through taxation is preferable to rationing" (Professor Lange, p. 16). It might be observed that the rationing is not the only way out. The price, then, might be allowed to rise, but the lower income brackets would be subsidized by something analogous to the Food Stamps. The advantage of this method is that resources, which are not needed by the government for armaments production, would be induced to relieve the sectional or local shortages. But it cannot be denied that the practical difficulties of this method would be considerable. Moreover, as Professor Lange points out, there is "no need for rationing of consumption goods (particularly foodstuffs) at present or any conceivable future date."

When speed is necessary, as it obviously is in matters of national defense, the market mechanism may simply prove too slow to be relied upon. This may lead to direct conscription of resources (requisitioning and priorities) as the only practicable alternative. However, to quote Professor Lange, "as a method of mobilizing resources for national defense, conscription should be used only as a last resort" (p. 17). For it leads to a less economical allocation of resources, and is rather dangerous from the political point of view. The conscription of labor, as distinct from other resources, "should never be resorted to in a democracy, except at moments of supreme emergency" (p. 18).

The hostile attitude of the authors of the "Economic Mobilization" toward conscription of resources or labor does not imply a benevolent approval of sectional pressure groups endangering and obstructing the progress of the national-defense program. In this connection the labor conflicts and restrictive monopolistic policies figure most prominently.

With respect to labor conflicts, Mr. Harbison emphasizes the comparative insignificance of the wage issue. "The top labor leaders," he says, "are not anxious to shoulder the blame for the rise in the cost of living as a consequence of pressure for wage increases." This does not seem to be Professor Moulton's view. "The greatest single source of inflationary danger at the present juncture," he says, "is to be found in increasing wage rates. . . These increases have resulted in part from competitive bidding by producing establishments for certain types of labor, and in part from pressure on the part of labor organizations" (p. 25). It is, unfortunately, too early yet to ascertain whose description of facts is more realistic.

The real danger to industrial harmony, according to Mr. Harbison, is likely to arise out of labor's desire for recognition and the employers' refusal to deal with the unions. However, the author rightly points out that the public is in no mood to tolerate strikes and lockouts during the period of national emergency. He therefore suggests a series of measures favoring mediation or voluntary arbitration (the Defense Mediation Board, created recently, fills the gap to a considerable extent). In case of failure of the mediation efforts, the author suggests that the strikes and lockouts might be prohibited "pending an impartial investigation of the facts concerning disputes, without, of course, impairing the ultimate right to strike" (p. 35).

No less dangerous than the industrial conflicts, though much less conspicuous, are certain monopolistic practices. The monopoly, where strong, may resort to restrictive price policies, unless the government will agree to guarantee the desired level of profits or, for instance, partial immunity from taxation. Moreover, it is in the very nature of monopoly to restrict output below the socially optimal level. This, of course, conflicts directly with the basic aims of the defense program. It is, therefore, of paramount importance that the government have a definite policy when obstacles of this type are encountered.

Although government interference is connected with well-recognized dangers, it may still be preferable to "self-government of industry" *if* by the latter is meant the predominance of sectional interests over public welfare and security. But, as Mr. Lewis puts it, "are we going to resort to totalitarian methods ourselves while in the process of defending our democracy against totalitarianism?"

Evidently, the utmost caution must be applied, and the stronger antimonopoly measures must not be resorted to if the "gentler" ones prove sufficient. These measures, as outlined by Professor Lange, range from compulsory pooling of all patents vital for national defense to the creation of publicly owned and operated yardstick plants and even, if need be, public operation of industries. Referring to price regulations combined with output quotas and public operation of industries, Professor Lange says: "The last two measures are extremely strong, but the survival of the nation is too high a value to be jeopardized in order to cling to the status quo" (p. 22).

Another aspect of this problem, namely the postwar developments, is considered by Mr. Lewis. He recognizes that "the controls set up by the government during the war emergency would persist after the emergency was over." However, since the government, unlike the private bodies, would be responsible to the electorate, the government controls could be removed more easily than the private ones, he argues.

Professor Moulton approaches the postwar problems from the point of view of financial policies. "The achievement of a balanced budget," he says, "and the prevention of further growth of the public debt would not only mitigate the depressing effects of high taxes after the war, but would also give a basis for confidence in our own ability to maintain fiscal and financial equilibrium in the future" (p. 28). Here again the

conclusion is hardly controversial, but not so the argument. Leaving aside the confidence aspect of the postwar situation, why is it true that the prevention of further growth of the public debt will mitigate the depressing effects of high taxes after the war? The old-fashioned, now generally abandoned, argument used to be that loans shift the burden of taxation to future generations. However, it is commonly agreed that this argument is fallacious and based on false analogy with *external* borrowing.

The "modern" explanation, on the other hand, is that the present increase in the public debt necessitates a transfer of purchasing power from taxpayers to bondholders when the war is over. Now if the bondholders happen to be on the whole less inclined to spend their income than the taxpayers are—there may be a deficiency of consumers' demand. But, as Dr. Bloch points out, the deflationary effect of debt repayment may be neutralized by an appropriate taxation policy. This possibility, however, does not change his belief that it is preferable to resort to taxation instead of borrowing as soon as the full employment is reached. Whether Professor Moulton would subscribe to the wealth-transfer argument is not quite clear. It is possible that he simply regards the balanced budget as a necessary condition for avoidance of inflation, and since postwar inflation would have to be stronger if war inflation was considerable, *ergo* a balanced budget will largely remove the danger of postwar deflation and so mitigate the burden of taxes.

The two pamphlets discuss many other questions of importance and interest which had to be omitted from this review. But in fact there is only one problem, namely, that of a sound economic policy in times of emergency. And, to quote Professor Douglas, "economic policy is only slightly less important in such a period of crisis than foreign and military policy."

Side Lights on History of Psychrometry

(*Continued from page 370*)

$$\frac{e' - e}{P\,(t - t')} = \frac{M_a C_p}{M_v r'} \left(\frac{k}{C_p \rho D_v} \right)$$

in which k = thermal conductivity of gas, ρ = density of gas, D_v = coefficient of vapor diffusion.

The contributions made to psychrometry by the men mentioned in this article cannot be overestimated. It is sufficient to state that the psychrometer is in extensive use and that the present-day psychrometric theories are partially or completely based on the convectional and diffusional theories.

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Ewing Galloway, N. Y.

MEN AND MACHINES AGAINST TIME

(Workman at engine lathe turning a pump shaft.)

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

En Bloc Radial Engine

AUTOMOTIVE INDUSTRIES

THE radial engine, so successful in aviation, has had practically no automotive success, according to Henry L. Brownback, member A.S.M.E., in a paper "Development of the Radial Engine for Military Uses," *Automotive Industries*, Feb. 15, 1941, from which the following is quoted.

From the beginning, and up to the present time, the radial engine has been under the same disadvantage as other types were before foundry technique permitted the cylinder block and the crankcase to be cast together, thus making a light and rigid assembly which could be manufactured cheaply and did not require a multiplicity of heavy parts which had to be machined separately at high cost and then bolted together.

The second disadvantage of the radial engine has been a very costly connecting-rod construction that is extremely heavy at the crankpin end, thus limiting rotative speeds.

A third disadvantage has been that cylinder and head were a permanent assembly and it was necessary to take off complete cylinder assemblies in order to be able to inspect and grind valves.

As regards motorcars and trucks, the radial design did not lend itself to front-end installations on vehicles with rear-end drive. In 1927 it was suggested to Anzani—who was then making many engines for the American market—that he should seriously consider the possibility of an engine having the cylinders and the center section of the crankcase all cast in one piece, using detachable cylinder heads and assembling the connecting rods through the large openings left when the end plates were removed. Such an engine would be light, very stiff, and very simple and cheap to manufacture and maintain. Anzani refused to consider the proposition, as no block castings of this type had been tried, and he was not convinced that the detachable cylinder head would work out.

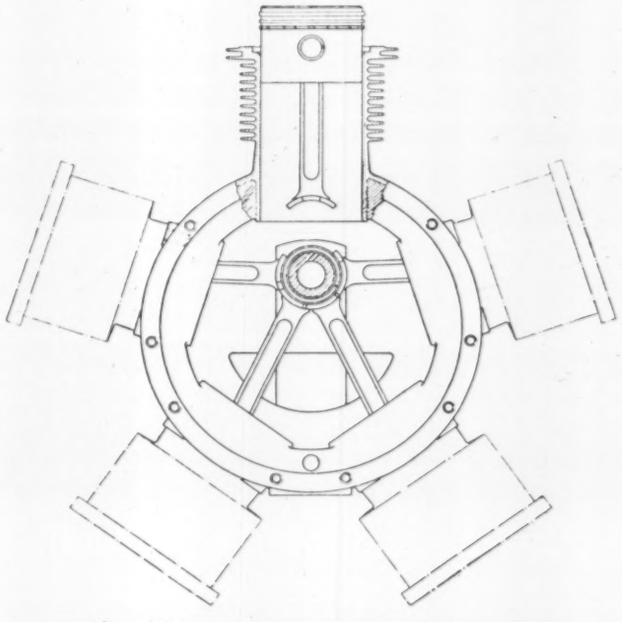

FIG. 1 SIDE VIEW OF FIVE-CYLINDER RADIAL ENGINE

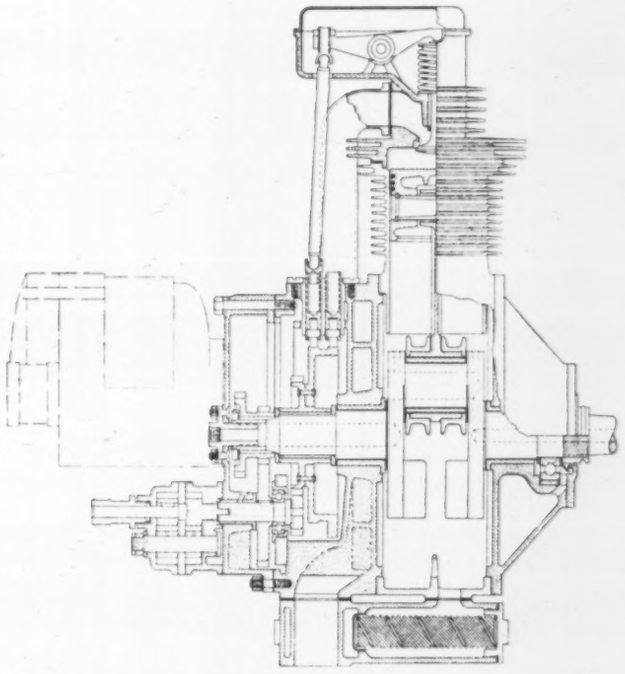

FIG. 2 LONGITUDINAL SECTION OF AN EN BLOC FIVE-CYLINDER RADIAL ENGINE

In 1928 the Brownback Motor Laboratories began the design of an aircraft engine in which it was hoped to be able to embody all of these ideas. However, the reluctance of foundries to attempt to make the block casting and the necessity of getting the engine on the market for the 1929 trade forced abandonment of the block-cylinder project but the other factors necessary for a one-piece engine were designed into the new engine and tried out. The "C400," as the engine was called, passed its government tests easily and achieved success under that name and as the "Light Tiger," in many airplanes and in dirigible balloons. Many of the cylinder assemblies were used as replacements on existing Anzani engines and in the manufacture of the three-cylinder Jacobs engine. Thus it was proved that the detachable cylinder head was practical on air-cooled engines of this size.

As the connecting rods and pistons of the en bloc radial engine would have to be assembled by passing them through the cylinder bores from the top, the use of the usual master and articulated connecting-rod assembly is impossible, except where the cylinder bore is very large and the stroke very short; in fact, the ratio must be almost 2:1. So we are forced to consider either a built-up master rod or some other type of rod assembly. Manly used a slipper rod, and the long line of very successful Anzani engines also used slipper rods, so these rods were used as the basis for the C400 design. In the Anzani assembly, three or five slipper rods were assembled on the outside of a split

babbitt-lined bronze bearing and held in place by split bronze collars which formed their external bearing.

It must be noted here that while as many as ten cylinders may be assembled to one master rod in the usual type of construction, space limits the slipper rod to five cylinders per bearing when the slippers work directly on the exterior of the bearing. In some of the leRhone radial rotaries as many as nine cylinders worked on one bearing, but the rod design was most complicated and costly. The Anzani bearing and collars floated, and all wear in the slippers, bearing, and collars tended to allow the halves of the bearing to separate. This resulted in excessive oil consumption and in severe bearing pounding.

In the C400 the bearing was split but had flanges finished to the inside diameter of the collars, so that the halves of the bearing were held firmly together. In some types one rod acted as a master, being doweled to the bearing and the collars. In this type, oil holes never uncovered by the slippers provided pressure lubrication for the slippers and the collars. Potez in France makes a slipper-rod assembly in which the crankshaft is built up and solid "dural" bearings and collars are used with a nitrided crankshaft and nitrided connecting-rod slippers.

Both of these constructions have produced assemblies which have run for hundreds of hours with no trouble, and which are not only cheap to manufacture but which require no fitting whatever when repairs are made, as the worn parts are replaced by standard parts made to definite tolerances in order to give definite running clearances.

While the master and articulated rod assembly gives an uneven motion to the pistons, due to the fact that only the center of the master rod passes through the center of the crankpin, the motions and the strokes of all pistons in the slipper-rod assembly are the same, as the centers of all of the rods pass the center of the crankpin.

Further, the big end and the rotating portion of the articulated rods of the master and articulated rod assembly are very heavy and cause heavy centrifugal loads on the connecting-rod bearings at high rotative speeds; the concentrated weight of the slipper-rod assembly is much less and permits higher rotative speeds.

With the slipper-rod construction, the engines have to be built in multiples of three or five cylinders. A five-cylinder radial engine has very good torque characteristics and a ten-cylinder is "velvety." In fact, many of our present high-powered radial aircraft engines are built in multiples of seven or nine cylinders, and it is rumored that some multiple-row engines of extremely high power are in the offing. It has now been found perfectly practicable to cast radial air-cooled cylinders and a crankcase center, strongly webbed and very light, in either aluminum alloy (which would be fitted with a nitrided sleeve) or in iron.

The combination of these proved features will solve the problem of producing both air- and water-cooled radial engines very cheaply, for both aircraft and automotive use, and for a given weight, engines thus built can be made far stiffer and sturdier than the bolted-together engines now produced, except in the case of some very large lightweight airplane engines. The radial engine has never been seriously considered as a competitor for the present type in cars and trucks because of its complication and cost, and because it did not fit into present designs.

However, the increasing use of rear-engined, rear-drive vehicles changes the picture considerably, as the radial engine combined with a fluid drive or a fluid flywheel and some sort of automatic or semiautomatic transmission would be most interesting from a weight standpoint. For a given horsepower the engine would weigh less than one half as much as present power plants.

Aircraft Plywood

JOURNAL OF THE AERONAUTICAL SCIENCES

MENTION has been made in the public press and in MECHANICAL ENGINEERING of the so-called "plastic" airplane. In reality, no plastic airplanes have been or are being built, but owing to the improved characteristics of modern plywood and improved methods of handling it, there has been simply a revival of aircraft plywood construction, once so popular. Thomas D. Perry, member A.S.M.E., of the Resinous Products and Chemicals Co., writes on "Aircraft Plywood and Adhesives," in the March issue of the *Journal of the Aeronautical Sciences*, and places the subject in its true light. In a report of the Ninth Annual Meeting of the Institute of the Aeronautical Sciences, to be found in the March issue of the *Journal*, in the Aeronautical Review Section, Alexander Klemin condenses Mr. Perry's paper as follows:

The use of plywood in the first world war was quite general in spite of disadvantages. It was not its inflammability, however, which acted as a limitation. The author correctly states that the major fire hazard is in the fuel and that, from a fire point of view, it matters little whether the material is fabric, plywood, wood, or metal. The real limitation was in the character of the adhesives, mainly casein and albumin glues. Such adhesives would not stand mold and fungi tests, and both encouraged parasitic growths with casein. Resistance to soaking and boiling water was unsatisfactory. Since 1930 and the rapid growth of the plastic industry, resin adhesives have come into use. Today resin adhesives of the phenol formaldehyde and urea formaldehyde group are available, and the following advantages have been secured: (1) complete waterproofness, adhesive insoluble until wood decays, (2) high resistance to bacterial growth, and (3) boilproofness, facilitating bending and curving after steaming. Liquid phenolics are found to possess

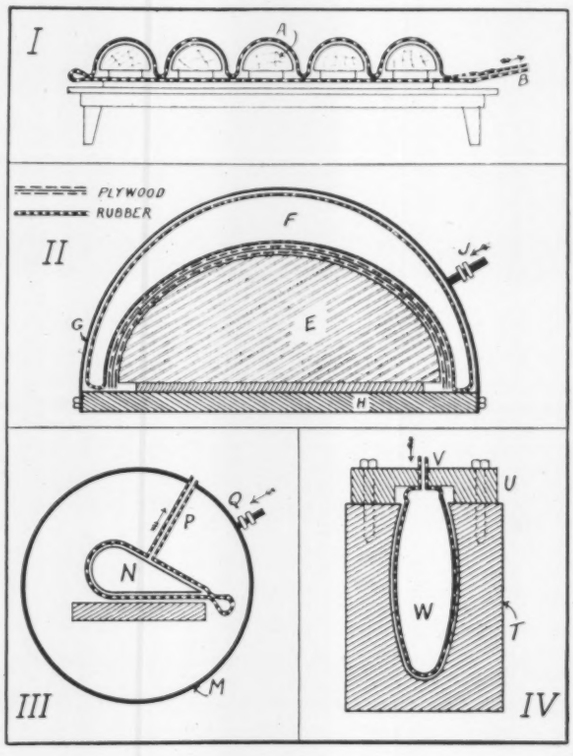

FIG. 3 PLYWOOD MOLDING PROCESSES

the same desirability as the resin in film form. The technique of bonding with film is particularly simple but whether phenolic film or liquid is employed the assembled sheets of veneer and adhesives are subjected to simultaneous heat (300 F) and pressure (125 to 250 lb per sq in.). Urea groups can be set at the low temperature of 70 F. Another important development is that of high-density plywood, sometimes called superpressed plywood, by impregnation and compression processes. The author writes, "This favorable change in plywood strength characteristics through increase of density is somewhat analogous to the alloying and heat-treatment of metals to improve their qualities. It gives to woodworkers an opportunity to meet design requirements that are far beyond the range of normal wood or normal plywood."

As previously stated, "plastic airplanes" is an inaccurate description as the airplanes so far have been merely made of molded plywood with resin adhesives and finish. The principles involved in molding plywood are old, and the only novel features were the methods of applying the pressure as well as the unusually large size of the molded unit. The fundamental principle involved is that of using an inflated or deflated rubber bag as one of the halves of a pair of molding dies. There is not only the saving in matching up a pair of dies where the intermediate distance between halves must be very accurately determined, but in many cases the dies are wholly eliminated and, in any event, rubber-bag pressure is of the order of fluid pressure and at substantially right angles to any surface that is under pressure. The Duramold, Turin, and Vidal processes all utilize this rubber-bag pressure principle. Several of the more important applications are illustrated in Fig. 3 taken from Perry's paper. There is not the slightest doubt that plywood now presents many new and undeveloped possibilities in the aircraft industry.

Steam-Turbine Nozzles

THE INSTITUTION OF MECHANICAL ENGINEERS

RESULTS obtained by C. A. Parsons and Company, Ltd., with a new type of static steam-turbine-nozzle tester are described in a paper "Investigation of Steam-Turbine Nozzle and Blading Efficiency," by F. Dollin, in the Proceedings of The Institution of Mechanical Engineers, February, 1941. The static nozzle tester, which uses air under pressure instead of steam, is also described.

Mr. Dollin's conclusions are as follows:

The efficiency of turbine nozzles is not determined solely by the shape of the passages. With passages of geometrically similar shape the flow losses, expressed as a percentage of the energy of flow, will be the same if the flow patterns are similar. To achieve similarity of flow pattern, not only must the passages be similar in shape, but also the relative effect of viscosity must be the same. This result is obtained when the size of the passages and the velocity, density, and viscosity of the working fluid combine to form equal values of a number which, from its precise analogy with the well-known function used in presenting pipe friction data, may be called the Reynolds number.

The efficiency of a reaction-blade profile can be expressed as a continuous function of this Reynolds number. Results obtained from the nozzle tester and various experimental turbines are shown to be mutually consistent and may be considered as approximating to absolute values, provided they are interpreted in the manner indicated.

The dependence of blading efficiency on Reynolds' number is a key to much that has not heretofore been clear in turbine performance. The very high efficiencies of water turbines as compared with steam turbines probably are attainable because of the high values of Reynolds' number in the former. Efficiencies of over 90 per cent have been obtained in steam turbines where the conditions are favorable, namely, high Reynolds' number, small clearance loss, and no wetness loss. Again, it is commonly found that the high-pressure unit of a two-cylinder turbine shows an extremely high efficiency as indicated by pressure and temperature readings at inlet and exhaust. Such readings are often viewed with skepticism, but it seems likely that they may be not far wrong, as the turbines in question may have a high efficiency because of the high range of Reynolds' numbers in which they work.

Magnesium

INDUSTRIAL BULLETIN OF ARTHUR D. LITTLE, INC.

NEW structural metals of substantial importance are rare; almost the only example in modern times is aluminum. Through stimulation of rapid production expansion, the defense program is hastening addition of another, magnesium, to the list, says a brief article in the *Industrial Bulletin* of Arthur D. Little, Inc., for March, 1941. Though the lightest of the structurally useful common metals and stronger than aluminum on a weight basis, magnesium until recently has been used chiefly for its chemical properties, notably its affinity for oxygen, which permits it to combine with and remove the last traces of oxygen from baths of molten metal or from radio tubes and which is responsible for the brilliant flash of magnesium flares. Following extensive foreign development of structural uses, magnesium production in the United States began to rise sharply in the early thirties because of increasing appreciation and use of light high-magnesium alloys in business machines, portable tools, vacuum cleaners, and particularly in airplanes, both military and civil. Sales of domestically produced magnesium grew from 900,000 pounds in 1929 and 1,400,000 in 1933 to 4,800,000 in 1938; the growth in domestic use was even sharper, since exports, which were said to comprise a large part of the market for the American product in 1935, were progressively decreased. With the sharp expansion of the military-aircraft industry starting in 1939, the rate of growth in use of magnesium was redoubled. Accumulated stocks were drawn upon and during 1940 the Dow Chemical Company, sole domestic producer, doubled capacity of its existing plant. In January, 1941, this company opened a new plant which will again double the company's capacity when full production is reached. For the present, however, the Office of Production Management has recently been forced to request allocation of all magnesium to defense production for the next three months. In addition, plans for construction of a large new plant by a second producing company have been announced, and reports have been current that as many as 12 or 15 companies are contemplating magnesium production. Scheduled output of the Dow Chemical Company in 1941 is 30,000,000 pounds, small compared with the 413,000,000-pound aluminum production in 1940, but, together with the expansion plans, indicative of the important status which magnesium has now attained as a structural metal.

Present domestic production is by electrolysis of molten magnesium chloride crystals, obtained from magnesium chloride hexahydrate by a difficult and rather expensive dehydration step. This crystalline material has been a by-product of the brines from which the Dow Chemical Company extracted salt, bromine, and other constituents, but the demand has apparently outrun the supply from this source. The company's new plant at Freeport, Texas, uses as raw mate-

rial sea water containing about 0.1 per cent magnesium, which is separated as the insoluble magnesium hydroxide by reaction with lime produced from near-by beds of oyster shells and is then converted to the chloride. Though the sea is as nearly an inexhaustible raw-materials source as can be imagined, local "depletion" is something of a problem. So large are the quantities of water treated that the effluent is directed to a convenient canal joining the sea several miles down the coast from the intake point, thus avoiding dilution of the incoming water.

The recently announced plant of the new producing company is to be located near San Francisco, to cost $12,000,000, and to have 24,000,000 pounds per year capacity. It will use an electrothermal rather than electrolytic process based on ore rather than brine as raw material. As with aluminum, magnesium-bearing ore is plentiful, but extracting the metal is difficult because of its high affinity for oxygen. In the Hansgirg process, which this plant will reportedly use, the oxygen combined with the magnesium is taken up by coke to form carbon oxides in the high temperature of the electric-arc furnace. The mixture of elemental magnesium vapor and carbon oxides thus produced must then be cooled quickly, since at intermediate temperatures the oxygen would return to the magnesium. In the Hansgirg process this is accomplished by shock cooling with large volumes of hydrogen; in a process developed by the U. S. Bureau of Mines, and soon to be in pilot-plant operation, an oil spray is used. The Hansgirg process is reported to have been in use in England, Korea, and probably Germany despite serious production difficulties which were encountered.

Two important factors in electrothermal magnesium production are ore and low-cost power. Richest ore is brucite (magnesium hydroxide), found in large quantities in the isolated and often snowbound Paradise Range in Nevada. There are large deposits of magnesite (magnesium carbonate) in Washington State, where low-cost Grand Coulee power will soon be added to the supply from Bonneville. Near Boulder Dam are large quantities of dolomitic magnesite. In the East, dolomitic limestone, from which magnesium could be produced in conjunction with other products, is available at various points.

Along with the increase in magnesium production capacity, fabricating facilities have been sharply expanded. The leading fabricator, American Magnesium Corporation, has expanded foundry capacity to several times the prewar level, opened an old, unused plant, and built a new magnesium die-casting plant. The Ford Motor Company has begun construction of a foundry with 110,000 pounds per month capacity, most of which will be used by that company.

Increasing aircraft consumption of magnesium alloys is due both to growing per-plane use and to rising aircraft production. Although in early 1940 less than 1.2 per cent by weight of the raw materials for a typical military airplane engine and one per cent of the airframe and propeller were magnesium, there is every indication that these percentages are rising and will continue to do so. Engine nosepieces and crankcases, housings of many kinds, control columns, rudder pedals, doors, floors, seats, and countless other parts have been made from magnesium alloys. Sand castings are said to be the most common mode of use, with die castings a close second. Use of magnesium-alloy sheet has been restricted by the difficulty of working it by standard shop practice, but is now increasing as methods for forming, riveting, and welding are evolved. Most wrought products have been relatively nonstressed parts, but magnesium control surfaces, fuselages, and wings are now

VARIABLE-SPEED CONTROL

(The lathe operator's left hand is on the control rheostat of the Westinghouse adjustable-speed alternating-current drive with the start-stop punch button directly above. On top of the headstock is seen the drive pulley of the series-wound direct-current driving motor, which has a speed range of 175 to 1750 rpm. Variable operating voltage is supplied by a single-unit motor-generator set consisting of a squirrel-cage induction motor driving a series direct-current generator. As the circuit requires no exciter, both control and wiring are simplified and the system is said to be more efficient than the ordinary variable-voltage system.)

being seriously studied. For these applications new high-strength alloys have been developed.

The best magnesium alloys after heat-treating and aging are almost, if not quite, the equal of duralumin in tensile strength on a volume basis; with a 37 per cent lower density, the strength-weight ratio of the magnesium alloy is correspondingly higher. Magnesium alloys require some special consideration in use; notches reduce the strength disproportionately; and neither heat nor wear resistance is high. Salt-water corrosion has been troublesome, but new high-purity alloys and chemical surface treatments are reported to lessen the seriousness of this problem.

Production capacity in use or announced as definitely planned is now some eight times that at the beginning of 1940. At the conclusion of the defense program the output of these plants will be available for civil aviation and for the countless industrial and commercial applications where lightness is highly prized.

Library-Laboratory Research

NEWS EDITION, AMERICAN CHEMICAL SOCIETY

THE place of the technical library in laboratory research is emphasized by Arthur Connolly in the *News Edition* of the American Chemical Society, for October 25, 1940. Mr. Connolly writes:

Hearing the word "research," the layman pictures a serious-faced individual in a laboratory, surrounded by mysterious apparatus. The scientist does much the same, except that the individual does not look too serious or unfamiliar, and the surrounding apparatus has no mystery. In each case, popular conception has a laboratory as the essential background, even though that is not the most important or most fertile field for research in many branches of science today.

Science has another setting for research—the library. Literature will reveal details on many an extensive research program now in progress, and doubtless on many programs of the future, perhaps years hence. There is also information on many inventions bound to exert profound effects upon our lives and living conditions. Such worth-while data repose in numerous well-equipped libraries throughout the country, but it is only the rare individual who intensively pursues what is so easily available. One wonders why a new type of research scientist does not appear—one who will devote his knowledge, diligence, and resourcefulness to library research.

When scientific literature was lacking or very meager, research necessarily meant laboratory investigation above all else. Today, scientific literature has attained tremendous proportions, and the volume increases at a much faster rate than it is digested and efficiently utilized. For that reason it should prove advantageous for the present-day research worker to spend much more time in the library, and correspondingly less in the laboratory, than is the general custom.

Library research would overcome two serious errors often made by scientists, duplication of work described completely and failure to appreciate inventions described almost verbatim in the literature.

To emphasize these failings in present-day research, we will observe a hypothetical scientist as he conducts his research from inception to the stage where it is made available to the public by patent or other publication. We must understand distinctly of course that he does not represent all scientists, or even the majority of scientists, but he does represent an important minority.

Our scientist becomes interested in, or is assigned to, a certain problem. He is to discover a new machine, perhaps—or a product or process—for which there appears to be great need. He may be acquainted with the general field surrounding this problem through his reading of well-known scientific journals. As a result he may predetermine approximately how his laboratory research should be conducted almost as soon as he undertakes the problem. He may or may not make a brief study of literature found in a well-equipped scientific library. Such study is for the purpose of obtaining "leads" whereby succeeding laboratory endeavors may be improved. But literature investigation is irksome, and our scientist wishes to complete it with a minimum of effort. A sketchy "survey" completes the library research and he launches his laboratory program taking advantage of the leads uncovered.

Weeks, months, and even years may then elapse while a painstaking laboratory program is carried to conclusion. Results from this investigation grow from a few notebook records to sizable proportions, and from the mass of data collected our scientist finally selects results he considers outstanding. These are referred to a patent attorney with instructions to obtain patent protection. The patent attorney embodies the outstanding results and supporting data in a patent application to be filed in the Patent Office. Shortly thereafter our scientist may publish approximately the same data and results in a scientific journal.

But the examiner to whom the patent application is referred notifies the attorney that the patent cannot be granted. His preliminary examination of the application and the prior art has brought to light a few prior patents or other scientific publications describing many or all features of the invention with surprising accuracy. With amazement and chagrin our scientist then reads the patents and publications. They describe his research almost as completely as if he had collaborated in their preparation. Eventually he must concede that the "broader" features of his invention are old, though he may decide that some of the more limited features are new and patentable.

The patent attorney performs a major operation, paring claims of the patent application to a mere suggestion of their once robust outlines. Then follows a tug of war between the patent attorney and the examiner to determine whether a limited patent shall be issued or whether the application should be abandoned because it fails to disclose anything patentable. If the attorney finally succeeds, a patent is issued to cover a small portion of the field originally thought patentable. If not, the application is abandoned as a fruitless endeavor.

In whittling the patent application to a mere sliver or in forcing abandonment, the examiner relied solely on library research. He devoted to this investigation a few hours, or at most a few days, of his time. But he was able to obtain sufficient proof to satisfy a highly interested scientist that a large portion of a carefully executed laboratory research program was merely duplication. He did not rely on information not available to the public. All proof of unpatentability was from publications available to anyone taking time to find and read them. Thus we see a research program practically nullified because the laboratory phase was emphasized and the library phase pretty well ignored. The romance of discovering secrets of nature in the laboratory was preferred to the drudgery of reading and digesting dusty patents, pamphlets, and other scientific publications.

That this situation is not a rare occurrence may be proved by statistics. Annual reports of the Secretary of Commerce over a period of years indicate that about 30 per cent, more than 15,000 each year, of the patent applications filed are abandoned. The predominant reason for abandonment is that the subject matter disclosed in the application has already been described in published literature.

The present fee for filing a patent application containing no more than 20 claims is $30. This means about a half a million dollars paid to the Patent Office every year in filing fees on applications subsequently abandoned. Legal fees for preparing and prosecuting them are customarily several times the $30 filing fee. Cost of the research upon which they are based is generally many times the legal fees. Without question, the annual bill to industry for abandoned applications amounts to several million dollars. And this estimate does not consider numerous patents of dubious value which issue from the skeletonized applications. It merely suggests the annual loss largely attributable to overemphasis on laboratory research and neglect of library facilities. Practically every dollar might have been devoted to pioneer research to extend frontiers of our knowledge at a faster and more profitable rate than is now the case. Time would have been saved for all concerned had the literature been thoroughly investigated in the beginning. A small fraction of the laboratory program cost would finance library research, and with numerous bona fide research problems confronting us today it is a pity to waste time, money, and talent each year on fruitless and unnecessary projects.

There is another serious error in slighting library research—failure to uncover many inventions published in rather obscure form. To perceive these requires concentration and imagination. It is necessary to correlate various publications and "read between the lines." The inventions are there for the able, diligent, and conscientious investigator, but one who will not study literature sufficiently to find what is clearly described therein is certain to miss this less obvious type of invention.

Frequently one short mental step beyond a publication or a small group of publications means a discovery of far-reaching importance. This step follows so logically from careful reading by an able scientist that the wonder is why it was not recognized before. Scientists often exclaim after a particularly important invention has been published, "Why, I knew that all the time!" or, "That has already been described in the literature." Such a remark is generally dismissed as hindsight or as a peculiarity of the research scientist, but it deserves more attention. In many cases 99 per cent is truth. The 1 per cent inaccuracy is the fact that the speaker missed the full significance of the publication when it first came to his attention. He failed to take the last mental step connecting the publication and what was invented by another. When the invention was finally brought to his attention, the last step appeared so simple and obvious he failed to realize that he had not appreciated it before.

This lack of appreciation was not intentional, but was a consequence of failure to place proper emphasis on library research. Many a scientist is too busy accumulating data to take time for a complete and analytical evaluation of either his own or published data of others. It is even more difficult for him to correlate published results of other investigators to determine whether they point to an important but unmentioned conclusion. As a result scientific literature increases at an amazing rate and many important inventions are submerged in it, to be rediscovered later, perhaps by scientists not born at the time the inventions became part of the literature. Some of the most important inventions of this era were discovered years after they had been described almost in their entirety in the scientific literature. The last step only was missing, and it took years for the scientist to supply it from the laboratory.

The two evils discussed, costly repetition of research already described completely in the literature and failure to appreciate inventions described almost verbatim in the literature, will continue until the scientist gives to library research the attention it merits. Already the time has come when research programs should provide a definite place for a new type of scientist. This scientist will devote all, or the greater part, of his time to thorough investigation of scientific literature. His research will be marked by the thoroughness, concentration, imagination, and resourcefulness of brother scientists in research laboratories. He will guide laboratory programs from the pitfalls of prior art. He will unearth innumerable inventions now hidden in the literature, and he or his fellow scientists will check these library discoveries by laboratory tests.

With proper balance and cooperation between the laboratory and the library scientists, millions of dollars wasted annually in repeating old investigations will be saved. The stream of data continually increasing the volume of scientific literature will be carefully searched, correlated, and efficiently utilized. Important inventions will be speedily skimmed from the literature instead of reposing unknown and unused. Our industrial research will then attain a new efficiency peak and frontiers of knowledge will expand more rapidly than ever before, to the advantage of scientists, industry, and civilization.

General Electric Co.

MAGNETIC THICKNESS GAGE FOR SHEET STEEL

(Said to be accurate to one thousandth of an inch in measuring the thickness of sheet steel when one side is accessible, this instrument consists of a seven-pound portable indicating unit which is connected to an electric outlet, and a small cylindrical head containing an alnico magnet. When the gage head is placed against the steel sheet, which must not be backed by other magnetic material, the permanent magnetic field of the head saturates the material. How much magnetic flux passes through the gage-head magnetic circuit depends on the thickness of the material. The thickness is indicated by the instrument reading which is a measure of the increased reluctance of the magnetic circuit.)

COMMENTS ON PAPERS

Including Letters From Readers on Miscellaneous Subjects

Defense and the Engineer

To the Editor:

At present three important defense problems need to be solved without loss of time: (1) Getting the right men into the right jobs, (2) getting inventions to the right defense agency, and (3) bringing the technical problems of defense to the attention of engineers so that their work can be of use.

There are several defense agencies and these turn to the A.S.M.E.'s trained personnel for help. They are the National Inventors Council, Commerce Building, Washington, D. C., which considers and solicits defense inventions; the National Defense Research Committee, 1530 P St., N. W., Washington, D. C., which deals with developments requested by the Army or Navy; and the National Advisory Committee for Aeronautics (N.A.C.A.), 3841 Navy Building, Washington, D. C., which considers inventions and coordinates research in aviation problems including those involved in defense.

An important part of the national-defense job can be done only if we all now take the initiative in bringing the abilities of specially qualified men to the attention of industrial firms and particularly to the National Inventors Council.

One thing that can be done to spread thin the engineers remaining in industry is to avoid unnecessarily strict specifications, to be as liberal as possible in inspection, to stick to standard products as far as possible, and to ask industry to turn out only what it is already making or tooled up to make. An exception is where some improvement will greatly reduce the consumption of some defense necessity, e.g., a light foreign-type motorcar might be made and widely used by our civilian population to reduce the consumption of gasoline.

Engineers who have any defense ideas should write the N.I.C. for its Bulletin No. 1. In general if an inventor wishes any tangible return for his idea, he must file a patent application and, upon its being held to be for a defense secret of value to the Army or Navy, must unmistakably tender it to the same. Upon excellent authority it may be stated: Since the acts of Congress making appropriations for the military establishment provide only for the use of such appropriations in the purchase of Letters Patent or of applications for Letters Patent, and licenses under either, the War Department requires, before recompense can be made for an invention, that a patent covering the invention shall have been obtained, or that an application for patent shall have been filed and one or more claims thereof have been indicated as allowable.

A statement in the penultimate paragraph of a recent condensed article by Stuart Chase in the *Reader's Digest* for January, 1941, that inventors who are solely interested in financial return had probably better not submit ideas to the N.I.C. is not consistent with the expressed aims of the N.I.C.

Engineers are too small and too independent a group to receive much consideration in a democracy which contemplates defense without sacrifices by either labor or industry. However, no fair question can arise as to the patriotism of any inventor who does not freely donate his ideas since they may be a needed source of livelihood for his family and himself. He can be assured that they will receive due consideration, be kept confidential, and that their submittal will not cause the loss of any rights or require earlier filing of applications than would otherwise be necessary unless public use should occur.

Both a reading of any *Official Gazette* and the experience of the board of inventions in the last war will emphasize that free or unemployed inventors expend an enormous amount of energy which is totally unproductive simply because the inventors tackle problems without any clear comprehension of the actual questions and difficulties involved. A main purpose of this letter is to seek action which will result in bringing to such inventors a better understanding of defense problems.

In a democracy, there is some burden upon a governmental department to convince the public that it is not complacently forming a bottleneck of unsolved problems as well as that it is keeping "confidential" and "restricted" any solutions of such problems as are entrusted to it. Obviously there are valid reasons, apart from possible enemy gains, for such departments to hesitate about releasing information which would cause inventors to rush to the Patent Office with half-baked solutions of problems which they otherwise would not have known to exist, solutions which were already old in the minds of those who released the questions but which they were too busy to be able to take the time to protect. To have the advantage of additional minds working on these problems equitably requires that there be some chance for some tangible reward for such effort.

There is much native engineering ability that can be enlisted through professional and popular technical publications and special features in the weekly and daily press. This is primarily a professional reporting job which can best be done by skilled and intelligent interviewers of the men who are actually at grips with defense jobs. Engineers who can write clearly should also be useful as interviewers or their collaborators since a clear statement of a problem generally contributes much to its solution.

If an engineer happens to be experienced in some phase of defense work, he should try to relocate in the industry or governmental department concerned if he can do so without personal loss. If he becomes a governmental employee, he or his assignee will be unable to sue during such employment to obtain a return on any inventions he may have already made and which are used by the government. In general, he will do better in industry, especially if he is able to start the manufacture of a defense necessity by forming either a new concern or a new department in an existing concern.

The A.S.M.E. has numerous committees already set up with their members used to working together. Much use can be made by defense agencies of such groups and the knowledge of their members of others who would be of value on particular problems. However, sound professional ethics requires that such cooperation be not used to deprive other engineers of their livelihood. Also, an engineer in industry must remember his obligation to his employer, as well as to his country,

if their relation is to be more than temporary.

The forty-hour week for engineers in industry provides them with spare time in which they can work on defense problems with valuable results if they are given a fair statement of the problems involved and have reached the point where they no longer require supervision.

And the exercise now of individual initiative by capable engineers will go far toward avoiding a future cry of "Too little and too late."

E. S. SMITH.[1]

Mental and Social Waste

TO THE EDITOR:

I notice on page 154 of your February number an article headed "Mental and Social Waste." In the middle column there is a statement, which seems to me to mean that the vowel "u" is pronounced the same in the words "put," "tune," and "student." To me, these "u's" are all pronounced differently. In neither the golf word "put" nor the word "put," meaning to place, is the "u" pronounced the same as the "u" in student. Furthermore, some dictionaries give only one pronunciation for the "u" in tune, which is the iotaized form of the letter "u" the same as the vowel sound in the word "dew," although there are dictionaries which give a *secondary* pronunciation of the "u" in "tune" as if it were pronounced the same as the vowel sound in "soon."

A. H. PUGH.[2]

[1] Patent Agent, C. J. Tagliabue Mfg. Co., Brooklyn, N. Y. Mem. A.S.M.E.

[2] The A. H. Pugh Printing Company, Cincinnati, Ohio. Associate A.S.M.E.

Cooling Concrete

COMMENT BY R. WELLER[3]

The question arises in the cooling of structures of the nature described in this paper[4] as to whether an analysis has ever been made of the optimum spacing of the cooling pipes on the basis of the known properties of the concrete in question. It would be interesting to know why a space of 5 ft was employed in the present instance.

A second question concerns the development of stresses in the immediate vicinity of the cooling pipes. Here a large temperature gradient is present and it would seem possible that a good deal of local failure might take place in such regions. If this question has been investigated it would be interesting to have data regarding these stresses in the Grand Coulee Dam.

COMMENT BY L. J. SNYDER[5]

This comment is intended to supplement the information contained in the author's excellent paper relative to materials and methods used and observations made by field forces of the Bureau of Reclamation on cooling the concrete of Grand Coulee Dam. The subject has been covered so carefully and completely by the author that this comment will of necessity be brief.

[3] The State College of Washington, Pullman, Wash.

[4] "Cooling the Concrete of Grand Coulee Dam," by Clarence Rawhouser, MECHANICAL ENGINEERING, vol. 62, Oct., 1940, pp. 715–718.

[5] Associate Engineer, United States Department of the Interior, Bureau of Reclamation, Coulee Dam, Wash.

DESCRIPTION OF MATERIALS USED IN SYSTEM

Selection of the proper materials is essential to the satisfactory operation of the concrete-cooling system, with minimum cost. The pump barges at the upstream face of the dam are connected to the embedded intake pipes by means of 20-ft sections of 12-in. rubber discharge hoses. One or two sections of hose are usually required at each barge. Sections of the embedded intake pipes at the upstream face and at the gallery are entirely of brass to insure permanency instead of rusting away in a few years as would probably be the case for iron or steel pipe. When the intake has served its purpose, a brass blind flange with brass bolts is installed at the upstream face of the dam and the inlet is backfilled with concrete. After the backfill concrete has shrunk, the space between the concrete and pipe is filled with grout under pressure, thus eliminating any possible leakage along the line of the embedded inlet. The main headers in the longitudinal and transverse inspection galleries vary in size from 14 to 6 in. The pipe is of the spiral-weld lightweight type, and is used in 10-ft lengths to facilitate handling within the galleries where space is often limited. Dresser-type compression couplings are used at all connections except for an occasional welded joint. The supply and return risers in the $3\frac{1}{2}$-ft-diam vertical cooling shafts are made up of standard flanged sections in 5-ft lengths to conform with the 5-ft lifts of concrete and to facilitate handling.

One rather difficult problem was to obtain a low-cost expansion coupling which would not leak at points where the embedded 1-in. cooling pipes cross the contraction joints. Throughout the construction of Boulder Dam and the foundation of Grand Coulee Dam, considerable trouble was experienced from leaky couplings. Since the blocks are staggered along transverse joints, and all shrinkage due to concrete cooling is toward the centers of the blocks, it is evident that the expansion coupling at any point along the transverse joints of the dam will be subject both to tensile and shearing stresses as the contraction joint opens. This combined tension and shear on the couplings proved to be too severe for all types tried, except those now being used, details of which are shown in Fig. 1 of this comment. It is believed that the main factors which make the coupling work satisfactorily are the use of the metal follower ring, which permits tightening of the jam nut without twisting the gasket, and the use of the $\frac{3}{4}$-in-length gasket, set back over $\frac{3}{4}$ in. from the end of the expansion coupling where the shear exists.

PROCEDURE IN COOLING

The mass concrete of the dam is made up of 87 cooling zones, each 50 ft thick, approximately 6 blocks or 300 ft wide, and bounded by the upstream and downstream faces. Cooling is started first at the lowest coil within the zone and then from the coils above as each is completed by the pouring of the various blocks within the zone. Cooling is usually started from each coil within 24 to 48 hr after it is covered with concrete to a minimum depth of 5 ft.

There are numerous ridges and depressions in the foundation rock, resulting, during the early stages of construction, in some parts of a block being quite thick while other parts are relatively thin. Unless cooling and shrinkage follow construction closely, loads will be concentrated on high points of bedrock, due to shrinkage of the deeper sections of the block, and vertical shear cracks may result.

During concrete-cooling operations, the flow of water throughout the distribution system is regulated at regular intervals to obtain uniform cooling of the mass concrete. This regulation is obtained by adjusting all main valves (4-in. and larger) so as to equalize pressures throughout the distribution system. Since most of the embedded cooling coils are of nearly equal length, the flow through each is equalized, as a result of the equalized pressures in the main headers. Accurate flowmeters are used to determine the flow from each of the pump

barges. The pumps are regulated so as to supply an average of 4 gpm for each coil connected to the system.

CONTROL OF COOLING

The resistance thermometers used in controlling the cooling operations are in most cases accurate to within a fraction of 1 F. In November, 1936, river diversion was started over one of the low rows of blocks of the dam in which 8 resistance thermometers were embedded 5 ft below the concrete surface. At the time diversion was started, the thermometers indicated temperatures ranging from 90 to 99 F while 11 months later, after the concrete temperatures were equalized by river flow, the temperature range of these same 8 thermometers was 54.4 to 54.8 F which is evidence of their accuracy. A three-wire lead is used between the embedded resistance thermometers and a terminal board in the gallery to eliminate the effect of lead resistance in making a reading with a Wheatstone bridge, calibrated to read in deg F.

An attempt is made to complete simultaneously the cooling, to the desired temperature, of all blocks within a zone and to complete cooling of the zones in the order which will facilitate and minimize the cost of grouting the contraction joints, where this work closely follows the cooling operations. During concrete-cooling operations, periodic temperature readings are taken on the embedded thermometers to obtain the temperature history of each. If the rate of cooling is found to be relatively slow in all or part of a cooling zone, an investigation is made immediately to ascertain the cause. The cause is always found to be inadequate circulation of cooling water and is in most cases easily remedied. Causes of inadequate circulation are closed valves, low pressure in the supply line because of need for additional flow regulation, kinked hoses, unusually long coils, and debris in the lines.

The concrete is usually subcooled 2 to 5 deg below the desired temperature of 45 F, in order to allow for the slight temperature rise which occurs, because of heat generated from continued hydration of the cement, after cooling is stopped and before the contraction joints are grouted. A section of the left abutment of the dam which was poured during the summer and fall of 1936, was artificially cooled to an average temperature of 41.7 F by April, 1937. The construction of the top blocks in this section was not completed until several months later, making it impossible to grout the contraction joints for approximately 1 year. In March, 1938, concrete cooling was resumed in this section as an average temperature rise of 7.2 F had occurred, because of continued hydration of the cement.

It has been possible to remove an immense quantity of heat from the mass concrete during the winter months because of the low river-water temperatures. On January 3, 1937, 5730 gpm of water were pumped through the embedded cooling coils. The temperature of the inlet water was 33.4 F, while the temperature of the outlet water was 55.8 F, making the equivalent refrigeration for that date 5340 tons, where 1 ton is equal to the removal of 288,000 Btu.

Concrete-cooling operations at Grand Coulee Dam are directed by the writer or by men in his organization, all working under the supervision of B. A. Hall, chief inspector. A. F. Darland is construction engineer, and F. A. Banks is supervising engineer for the Bureau of Reclamation at Grand Coulee Dam.

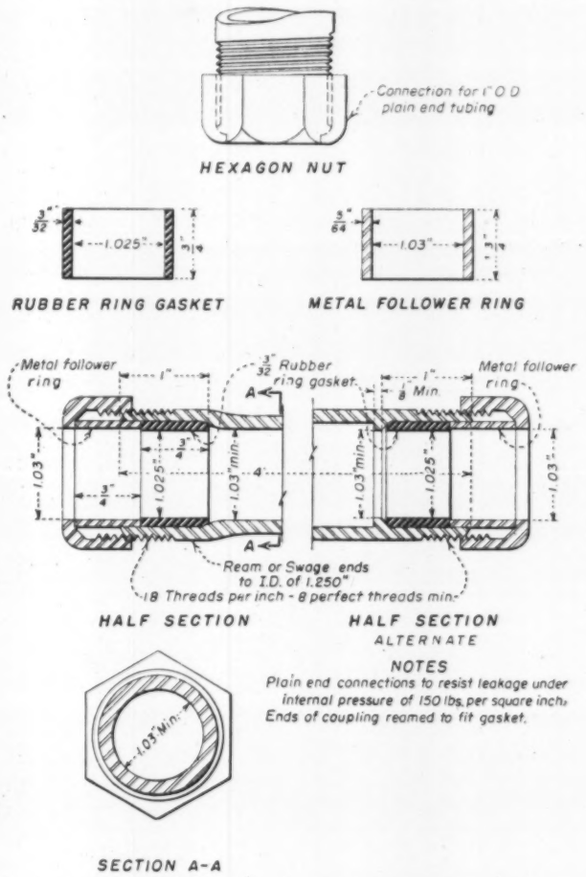
Connection for 1" O.D. plain end tubing
HEXAGON NUT
1.025"
RUBBER RING GASKET
1.03"
METAL FOLLOWER RING
Metal follower ring
Rubber ring gasket
Metal follower ring
Ream or Swage ends to I.D. of 1.250"
18 Threads per inch - 8 perfect threads min.
HALF SECTION
HALF SECTION ALTERNATE
NOTES
Plain end connections to resist leakage under internal pressure of 150 lbs. per square inch.
Ends of coupling reamed to fit gasket.
1.03" Min.
SECTION A-A

FIG. 1 DETAILS OF EXPANSION COUPLING; 1-IN-OUTSIDE-DIAM TUBING

AUTHOR'S COMMENT

The descriptive comments by Mr. Snyder are appreciated and contribute materially toward completing the original article.

Professor Weller's comments and questions are quite pertinent. There are so many other factors than the thermal properties of the concrete which influence the choice of pipe spacing that it is questionable whether a spacing on that basis alone could be considered the optimum spacing. It does not seem reasonable, with present materials and construction practice, to expect that the temperature can be controlled to the point of preventing any temperature change whatsoever. The placement of massive concrete in 5-ft vertical lifts is in itself a compromise of many factors, which has proved to be satisfactory in practice. The most logical location for cooling pipes is on the tops of the lifts, which determine a 5-ft, or multiple thereof, vertical spacing. Greater than 5-ft vertical spacing is neither economical nor effective. A horizontal spacing of from 5 to 6 ft, therefore, distributes pipes uniformly throughout the mass and enables the concrete to be cooled effectively and economically within a reasonable length of time. For more

definite control of temperatures at the contact surfaces with the foundation and with succeeding lifts, enabling large areas to be covered without contraction joints, it is advisable to decrease the horizontal spacing. At Friant Dam, in California, with a horizontal spacing of 2 ft 6 in. and with cooling started at the time of placement of concrete, 5-ft lifts 56 ft wide and 240 ft long are being constructed without cracking.

In answer to Professor Weller's question about stresses around cooling pipes, mathematical studies, assuming the concrete as truly elastic, indicate that tensile stresses, which might exceed the strength of the concrete, exist for a short distance around the pipe. Attempts to record the existence of cracks by installing strain meters around embedded cooling pipes have been negative. No cracks observed in service structures have been determined to have been caused by the presence of cooling pipes. The preferred procedure of starting cooling as soon as possible after placement imposes the large temperature gradients surrounding the pipes at a time when the concrete is relatively plastic and capable of deformation without cracking. Undoubtedly, the magnitude of stress and the formation of cracks are dependent upon a number of factors, most of which are widely variable during the early age of the concrete, such as, temperature range, thermal coefficient of expansion and contraction, modulus of elasticity, creep characteristics, and strength of the concrete. Whatever stresses may be imposed should be relieved, at least partially, by subsequent equalization of temperatures.

CLARENCE RAWHOUSER.[6]

[6] Engineer, Bureau of Reclamation, Denver, Colo.

Frozen-Earth Dam at Grand Coulee

COMMENT BY L. L. HOHL[7]

This interesting paper[8] presents some new and valuable physical data on frozen soil and constitutes as well a valuable contribution to technical literature on this infrequently used method of handling wet earth or sand.

The writer wishes, however, to comment upon some aspects of the heat-transfer data in the section, "Design Considerations." The author states: ". . . no data were available which applied directly to the time required for the freezing of earth." At the time of the Grand Coulee freezing job, there probably were no data published in English but, in 1937, work on this subject by Armin Schoklitsch, translated from the German by Schulitz,[9] was published by the Society. This contains a table[10] of thermal properties for more than thirty kinds of common rocks and soils. From such data, a rough estimate of freezing time could have been worked out. However, the thermal properties of rocks and soils often vary over wide limits even for quite similar materials and, of course, the moisture content plays a most important role in cases such as the Grand Coulee job.

The formula used at Grand Coulee, while it gave good results for this case, should not be applied indiscriminately to other cases. It is of limited applicability. The formula for freezing time used at Grand Coulee may be derived from Newton's law of heat flow using a path of constant cross section.

It reads

$$Q/\theta = KA(\Delta t)/L$$

in which

Q = quantity of heat, Btu
θ = time, hr
K = coefficient of heat conductivity, Btu per sq ft per deg F per ft per hr
A = area, sq ft
t = temperature difference between planes considered, deg F
L = distance between planes, ft

Using the value 1.26 for K; 143 Btu per lb, as the latent heat removed from the water in the freezing process, and water weight at 62.3 lb per cu ft, we may readily derive approximately the formula which is used by the author for freezing time.

Objections to this method, which would in many cases yield unreliable results, are:

1 The path of the heat flow is not of constant cross section, but the cross-sectional area of the path is proportional to the distance from the center (similar to the lagged-pipe problem), the formula for which is $Q/\theta = (2\pi K\Delta t) \div \ln (L_2/L_1)$ for the rate of heat flow per unit length of pipe (1 ft); L_1 being the outside radius of the pipe in feet and L_2 the outer radius of the freezing area.

2 The formula used at Grand Coulee is based on freezing 100 per cent water, i.e., 62.3 lb of water per cu ft, whereas, the material to be frozen contained only 40 lb of water and 77 lb of fine-grained material of the basalt type of rock with specific gravity of 3.45 and specific heat of 0.2.

3 No account is taken in the formula for cooling from ground temperature to freezing temperature.

If we use the method indicated in (1) for freezing 100 per cent water at 32 F, we find the time required to freeze a distance of 15 in. from the pipe wall 1550 hr or about 32 days. If, however, we are freezing only 40 lb of water per cu ft of earth at 32 F, as at Grand Coulee, we find, by this same method, that it would take only 995 hr or 20.7 days, conductivity of soil being the same as for ice in this case. This result almost coincides with the 20 days which the author found by his method. This coincidence is, however, fortuitous. The method at Grand Coulee ignores several factors, the neglect of any one of which may lead to erroneous conclusions in cases where cooling or heating tubes are used for freezing or thawing, respectively.

AUTHOR'S CLOSURE

The construction of the frozen earth dam at Grand Coulee was a small feature of a large construction project and was not carried on with the degree of accuracy attainable in a laboratory experiment. At the time the refrigerating requirements for the frozen-earth dam were estimated, the area to be frozen was under 110 ft of water, and the estimates made under such conditions did not warrant a high degree of refinement in the calculation of heat transfer. However, as the work progressed the data were collected in hopes that they might be of value on some future undertaking.

The comments of Mr. Hohl are appreciated in calling attention to the limited application of the formula used, and to the many omitted factors which might lead to erroneous conclusions.

The author's statement that no data were available which applied directly to the time required for the freezing of earth should be qualified by stating that such material was not available on the Grand Coulee project, and that the urgency of the job did not permit an extensive search for information.

LLOYD V. FROAGE.[11]

[7] Associate Engineer, Designs and Specifications, National Park Service, U. S. Department of Interior, San Francisco, Calif. Mem. A.S.M.E.

[8] "Frozen-Earth Dam at Grand Coulee," by L. V. Froage, MECHANICAL ENGINEERING, January, 1941, pp. 9–15, 36.

[9] "Hydraulic Structures," by Armin Schoklitsch, translation by Samuel Schulitz, THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, 1937.

[10] Ibid., vol. 1, p. 6.

[11] Assistant Engineer, U. S. Bureau of Reclamation, Coulee Dam, Wash.

Hydraulic Problems of the Pulp and Paper Industry

COMMENT BY T. AGRONIN[12]

This paper[13] deals with matters of vital concern to the designers of paper-mill pumps. In recent years the question of high consistency has become more and more important due to the adoption of refining by the industry in general. The author illustrates a refiner in his beater room for preparing the pulp; he also shows the stock at a consistency of 4 per cent entering the refiner.

It is understandable of course that the heavier the stock can be handled, the more work will be done to each individual fiber. In other words, for the same amount of power, the refiner will work on more stock and less water. It is for this reason that in modern mills the consistency through the refiner is kept at the maximum which can be pumped to the refiner. Therefore, the problem is in the hands of the pump designer.

Today, pumps have been developed which will handle practically all grades of stock at consistencies of 6 per cent. Some stocks can be pumped at 7 per cent. This brings up a point which the author notes, namely, the relation of consistency to freeness. It would be a great aid to the pump designer if someone could develop a scale which would include both freeness and consistency.

For instance, in cases where we handle some stocks as high as 12 per cent consistency in agitators, trouble is experienced with other stocks at 6 per cent consistency. This is due to the difference in freeness of the two stocks. This perhaps is more a problem for the chemists to work out than the mechanical engineer, but a solution would certainly be of great aid to the engineers.

COMMENT BY M. W. BLACK[14]

In the paper and pulp industry, the amount of water used is large and the importance of good engineering in the hydraulic field cannot be minimized. The difference between handling water and suspension of pulp in water must be especially impressed upon a hydraulic engineer who may be encountering this problem for the first time. It is only within the last decade that pump manufacturers and hydraulic engineers have given this particular field the specialized study it deserves and designs of pumps made (particularly in the centrifugal field) which are relatively efficient and satisfactory in operation.

For many years, the piston pump of the duplex or triplex variety with all the faults of high cost and lack of flexibility has been deemed necessary for many places where paper stock must be handled. The adaptation of centrifugal pumps to this service has been the cause of many a headache, due in most cases to the lack of appreciation of the specific characteristics of paper stock in suspension in water as pointed out by the author. The persistent habit of a centrifugal pump to air-bind is possibly the cause of more grief than any other one thing.

One item of major importance in the paper mill, to which the author gives a clue, is the formation of a sheet of paper on a Fourdrinier wire. This is essentially a hydraulic problem with all the difficulties inherent in paper pulp manufacture added.

To form a sheet of newsprint, for example, the properly treated pulp is suspended in water at a consistency of approximately 0.5 per cent. This mixture must then be placed on an endless wire cloth of say 60 by 44 mesh, traveling at approximately 1000 fpm, so that the pulp fibers are well separated and evenly distributed over this moving wire cloth in order that an even sheet of paper may be made.

To accomplish this result, there must be sufficient turbulence so that the fibers will be kept separate and not allowed to form into flocs or bunches. The mixture must be placed on the wire cloth so that the same amount of pulp and water is on each place on the wire or the weight of paper will vary across the machine, causing not only a poor formation but uneven drying in the drier section. The pulp and water must be fed onto the wire at approximately the speed of the wire, or the mixture will roll or wash on the wire. Either condition will spoil the appearance of the product. In addition, the natural tendency of pulp fibers is to become aligned in the direction of flow. If this condition is not counteracted, at least partially, the result will be a sheet of paper having good strength in one direction and very poor strength in the other direction.

The early paper machines equalized the flow by means of baffles in a head box and moved the stock onto the wire under a sluice (generally called slice) which built up a slight head behind it and allowed the stock to pass under it and over an apron onto the wire. The turbulence was regulated by the size and design of the passages in the head box and adjustments could be made on the sluice to equalize the volume of flow across the wire.

As speeds increased, it was found that flows onto the wire could be improved by pitching the wire downhill; the higher the speed the greater the pitch of the wire. The purpose was to equalize the speed of flow of stock and wire. Later it was found that equally good results could be attained by increasing the hydraulic head in the pond behind the slice to attain proper speed between stock and wire. This necessitated the design of nozzle lips, which easily and precisely could control the flow onto the wire. In due course, this design was adopted. Then, when boxes became too streamlined and turbulence was lost, shallow perforated rolls were revolved in the stock and water to improve this condition.

At the 1940 fall meeting of the Technical Association of the Pulp and Paper Industry in Seattle, Wash., W. G. McNaughton submitted 46 designs of stuff boxes and slices which have been or are being successfully used on newsprint machines; not one of which approaches the ideal of a papermaker as to perfect control of flow and turbulence which would give ideal operation of a paper machine. Most of the designs of the past have been the product of the papermakers, as the result of necessity, and built by trial and error.

This problem is offered as one vitally concerning every paper machine where much improvement is possible and widely divergent ideas and practice rule.

AUTHOR'S COMMENT

The design of a paper-machine head box and "slice" offers, as pointed out by Mr. Black, one of the paper industry's most interesting hydraulic problems. A further conception of this problem may be had by referring to the author's discussion of flocculation and also to the following paragraph:

Fiber flocs form naturally in water into gravel-shaped clusters as pointed out in the paper. In the design of the machine head box and slice, the goal of the hydraulic engineer might be stated as follows:

1 To break down all of the natural floc formation that may have occurred in the flow of paper pulp coming into the head box.

2 To cause the fibers to reunite in a formation similar in nature to the floc except that the new formation must be in the form of a sheet having a uniform dis-

[12] Shartle Brothers Machine Company, Middletown, Ohio. Mem. A.S.M.E.

[13] "Hydraulic Problems of the Pulp and Paper Industry," by M. L. Edwards, MECHANICAL ENGINEERING, vol. 62, Sept., 1940, pp. 665-669.

[14] Inland Empire Paper Company, Spokane, Wash.

tribution and arrangement of fibers the full width of the paper machine. This sheet must be formed at as high a consistency as possible and must be ejected at a velocity equal to that of the Fourdrinier wire and in a position that will permit its laying down on the wire in motion without rupturing or deforming the formation.

The suggestion by Mr. Agronin that a scale of values denoting the mechanical property of pulp which includes the factors of consistency and freeness might easily be answered by some manufacturer of consistency regulating equipment. A number of devices of this type are on the market which are not in a strict sense regulators of consistency, but rely upon changes in this mechanical property or fluidity for detection of change in "consistency."

An instrument of this type, having an indicating dial, if properly standardized and calibrated, would produce the scale called for.

M. L. EDWARDS.[15]

[15] Pulp Division, Weyerhaeuser Timber Company, Longview, Wash.

Redwood Forest Management for Utilization

COMMENT BY M. BRADNER[16]

The author of this paper[17] probably has a more intimate knowledge of the history, management, and utilization of redwood than any other forester in the United States. For many years, as associate professor of forestry at the University of California and as consulting forester for the California Redwood Association, he has carried the banner for the better protection, management, and utilization of our redwood forests. Much of the information now in published form has been compiled by Professor Fritz.

It would have been somewhat difficult for the writer to discuss this paper in a worth-while manner, owing to his rather limited knowledge of redwood forests, if the author had not so clearly stated the situation, the problem, and the ultimate objectives and suggested ways and means for their accomplishment. For many years, he has advocated a method of cutting in the redwood forests which would allow the operator to realize the greatest possible return and yet leave the cutover land as an asset rather than as a liability for future timber production. This is, of course, the ultimate aim of every forest manager. The author has made excellent progress in demonstrating to redwood lumbermen that, by a system of partial cutting which favors natural reforestation and by newer equipment and methods for logging and slash disposal, a profitable operation can be conducted which will, at the same time, leave the cutover land in productive condition. The permanency of the redwood industry depends almost entirely upon the private operators, as they own the bulk of the redwood forests.

The harvesting and conversion of redwood forests, especially where the trend is toward permanent production, presents many problems more difficult to solve than is ordinarily the case in other major forest types. As the author states, the great size and weight of the trees and logs, the rough terrain, the heavy accumulation of slash resulting from logging, and the tendency toward breakage make logging difficult and costly. Considerable progress in solving these problems has been made by the California foresters working in conjunction with the logger and the engineer. The author himself has made worth-while contributions. His work on the reduction of breakage losses in felling redwood and the use of tractors and arches in logging redwood have contributed much to the solution of these difficulties.

Many of the vexing problems in harvesting the redwoods must be worked out by the forester or forest engineer in conjunction with engineers. There are numerous engineering problems involved in logging redwood which will challenge the inventive genius of the mechanical engineer. The following forestry-engineering problems, as discussed by the author, will bear repetition for the sake of emphasizing their importance:

1 The place of the engineer in planning the logging operation.

2 Felling saws and felling technique to reduce losses in breakage.

3 A practical lowering scheme or device to reduce breakage losses in felling.

4 Plans and equipment for a central bark-peeling plant including rehandling (logs) machinery.

5 Chemical and mechanical means of utilizing the enormous amount of waste material left in the wood.

6 Yarding and skidding equipment and methods.

7 Truck-and-trailer equipment for woods-to-mill transportation, including loading and unloading machinery.

Here is a field in which the forest manager, the logger, and the engineer, by working together, can develop machines, methods, and techniques which will help to establish the redwood-forest industry of the Coast on a permanent production basis.

COMMENT BY D. S. JEFFERS[18]

The redwood trees, individually, stagger the imagination, and "seeing is (often not) believing." To think in terms of a redwood forest would almost cause one to back away from the problem, were it not for the realization that men, such as the author, have tackled the problem and are making headway with it.

Forestry and forest management, along with many other terms of a professional nature, are subject to so many varying definitions, particularly on the part of the layman, that one must be careful in discussing such a subject as that of the paper. The author has mentioned forestry as being primarily concerned with growing, tending, and management of forest properties. Many of us are coming to think of forestry as essentially the management of raw land and the marketing of the products thereof. Just as the term "engineering" has broadened and is broadening in its conception of the range of activities, so the word "forestry" must continue to broaden.

Certainly the need for intelligent logging practices is fundamental, if forestry is to succeed in the United States. The problems of raw-land management have too long been thought of as the opening door to agriculture. Raw land has its place in our economic structure, and we must attempt to market the products of the forest in a reasonably practical way or our raw-land management, in so far as forests are concerned, is deficient.

More emphasis is needed in order that the engineer and the forester may see eye to eye in relation to the problems of the forest. In the forest, as an economic entity, we are dealing with a resource but little understood and scarcely appreciated by our population. The problem of the logger, and of the forester as a raw-land manager, is becoming more and more complicated. As the author has so well said, the judgment of the owner and, it may be added, the judgment of the public will depend very largely upon the ability of the forester to deliver logs and lumber at a reasonable price.

The term "selective logging" is one which might have been discussed more in detail by the author. It is a term that is used rather loosely in many quarters. Some of the critics, and they are legion,

[16] Director, Northern Rocky Mountain Forest and Range Experiment Station, U. S. Forest Service, Missoula, Mont.

[17] "Redwood Forest Management for Utilization," by Emanuel Fritz, MECHANICAL ENGINEERING, vol. 62, December, 1940, pp. 859–863.

[18] University of Idaho, Moscow, Idaho.

say it is nothing more than "high grading." The critics go on to say that the original loggers cut selectively. In a way they did. That is, they chose only the tree that would pay and, more frequently than otherwise, took only the butt log after cutting high stump, because in their economics the butt log alone paid. Selective logging goes beyond the ledger page. Selective logging implies not only paying the operator a higher rate but paying the landowner a higher rate. Selective logging is a two-edged instrument which, when wielded wisely, brings results of high value for society in this day and for future generations. Selective logging involves not only the marketing of the present product but the ground cover that is left and the fire hazards which result from any type of logging. It has been demonstrated experimentally and in a sufficient number of actual cases to prove the point that selective logging wisely practiced does bring high returns to the operator. It remains to be demonstrated that future generations will profit equally well.

The forester in his management of raw land and in his planning for the marketing of his products is faced with an economic problem but little understood. Too often the operator-manager has known too little of the quality of his timber and has depended upon trial and error to meet his pay roll and secure a profit from his operation. Very largely, the location of roads, the adoption of a certain piece of machinery for skidding and yarding, or the decision as to where one type of skidding should supersede another is dependent upon the "break-even" point. The break-even formula is an old one, but it has not been used in logging or in forestry until comparatively recently. As the engineer develops better machines, the forest manager must be able to use to his economic advantage and not beyond that point.

If forestry were concerned only with "growing, tending, and management of forest properties," the forester would not be interested in the transportation problem from stump to mill to retail yard. More and more the markets of the United States and of the world are reflected in what we may do in the forests in cutting timber. Embargoes and tariffs have embarrassed more than one operator owner; particularly in the Northwest. Laymen little understand how marketing facilities and markets are reflected back into the forest where the hard-boiled logger is felling and bucking the logs. Not only the removal of the bark from redwood and the severe breakage which results in felling these mammoth trees, but the best markets for redwood and the competition that he must face are daily worries to the redwood operator.

Waste utilization is the "big bad wolf" in forestry. If it were possible to utilize the redwood bark and the redwood slash, as well as the Douglas-fir bark and Douglas-fir slash, the fire problem in brush disposal, the economic problem in skidding and yarding, and the transportation problem in trucks versus railroads would assume an entirely different aspect. The author has not placed too great an emphasis upon the problems of breakage, and bark and slash disposal. The engineer can be of great service to forestry in developing a machine which can lower the redwood tree cheaply and quickly, without breakage, in developing another machine which will remove the bark cheaply, and in aiding the forester in seeking markets for all of the waste material that results from this very valuable tree.

Redwood forest management, in the last analysis, depends upon the market for redwood. Machines will be developed, waste will be utilized, and the operator will make a profit whenever we recognize the high value of redwood as a lumber species. Competition between redwood and Douglas fir, white pine, and sugar pine, is not so much a problem for the forester and the logger as it is a problem for the engineer. The engineer is called upon over and over again to make recommendations for building materials. The engineer knows his stresses and strains, and endeavors, as he should, to supply his client with the very best material that the market affords.

Engineer and forester, owner-operator and consumer cannot expect redwood to be managed over the generations yet to come, unless redwood finds its place in our economic utilization. As the author so ably pointed out, the problems of the redwood forest are more difficult of solution than those in any other forest region. The best principles that the engineering and the forestry professions can bring to bear on the problem will be challenged by this great natural resource.

COMMENT BY C. R. PATRIE[19]

This is an unusually interesting and thought-provoking paper, and one which the writer feels does full credit to the author who is both a trained engineer and a successful forester. Perhaps it was because of this combined training that he has been able to realize clearly how truly progress in the practice of forestry is dependent upon engineering advances. No forester who has reviewed the development of forestry in the Western States can fail to appreciate the large part that engineering advances have played, for they have in fact made possible many approved forestry practices which otherwise would have been economically or physically impossible.

Foresters have learned much through continued and earnest research regarding the silvicultural requirements of the trees that make up our western forests and have developed cutting methods to conform thereto. However, they have been and still are faced with physical and economic obstacles which prevent them from placing these silvicultural practices into effect. Rugged topography, conditions of soil and climate, and the very size of the trees themselves made transportation and logging costly and difficult in the western forests. Then too, competition with other more accessible regions in the East and South was so keen that operating margins were narrowed to the vanishing point and it was financial suicide for any operator to log by any but the cheapest methods. These methods appeared for a time to be wholly incompatible with the practice of forestry, i.e., the maintenance of forest lands in a continuously productive state. It remained for the engineer to develop less costly and more flexible methods of logging which were less destructive of the forest cover and would permit the application of silvicultural principles.

We have seen the gradual development of the caterpillar-tread tractor and logging truck to their present high state of efficiency and we have also seen various modifications of the high-lead and skyline systems placed in effect. These engineering improvements have revolutionized logging in the western forests; they not only have made hitherto inaccessible areas available to the logger but have also greatly extended the possibilities for the practice of sound forestry. We now find selective logging being practiced successfully in the Douglas-fir and redwood types of the West Coast where formerly only clear-cutting had been believed possible. Other instances could be cited in which engineering improvements have been immediately followed by advanced forestry practices.

It is no doubt true, as the author states, that the redwood forester and engineer are faced with more difficult management and operating problems than are found in any other forest region. However, this is only a matter of degree, for the other regions still have plenty of work to do before the engineer and forester will both be satisfied. The talents of each are required to bring about economic efficient logging under sound forestry principles.

[19] Forester, U. S. Indian Service, Spokane, Wash.

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

The Railroad Problem and Its Solution

THE RAILROAD PROBLEM AND ITS SOLUTION. By John E. Muhlfeld. Devin-Adair Co., New York, 1941. Library buckram, 5½ × 8⅜ in., 290 pp. and index, illus., $3.

REVIEWED BY L. K. SILLCOX[1]

IN his book, Mr. Muhlfeld revives the arguments of the National Transportation Conference of 1933, dissecting the general recommendations and statements of principles outlined by that body to suggest specific directions in which these recommendations and principles might be realized. Mr. Muhlfeld has been delightfully independent in his approach. He has dared explain in his own way the basic factors responsible for existing circumstances in the railway industry.

He then offers such schemes and proposals for the rehabilitation of railway organization, operating principles, and physical plant as, in his opinion, will restore railways to profitable operation on a national basis. There is not a detail which has escaped. Equipment, and particularly railway motive power, receives extended comment. Railway finance and labor relations are dealt with.

Many will disagree with Mr. Muhlfeld's explanations and conclusions. However, he has been very definite in expression and thus has provided a long line of starting points for direct discussion. Certain statements recur throughout the book and in parts more exacting editing would improve continuity. It serves its purpose well and provides a good and very broad picture of the railway situation as it exists today, including the tonic of fearless comment and prophesy.

"The Railroad Problem" should appeal to a broad group of readers interested in problems of the railways, not as broad, perhaps, as the jacket review would indicate. Definite railway interest and sympathy are characteristics essential to the reader who will enjoy Mr. Muhlfeld's book and it is not one for the specialist in a single branch of railroading who is looking for an exhaustive textbook relating to his specific interests and who is relatively unconcerned with the relationships between his work and that of other divisions and departments of the industry.

[1] First Vice-President, The New York Air Brake Co., Watertown, N. Y. Mem. A.S.M.E.

Do You Know Labor?

DO YOU KNOW LABOR? By James Myers, National Home Library Foundation, Washington, D. C., 1940. Boards, 5½ × 7¾ in., 126 pp., bibliography, $0.50.

REVIEWED BY R. CARTER NYMAN[2]

THIS book surveys recent significant developments in labor relations comprehensively but concisely. Dr. Myers deals with such topics as strikes, the craft versus industrial-union controversy, and the National Labor Relations Act factually rather than emotionally—even though his facts are mostly selected from only one side of the list.

While such questions as consumers' cooperation, workers' education, and labor and world peace are discussed, the chapters on labor unions and labor relations are particularly interesting. Dr. Myers persuasively argues for democracy in labor relations and that labor unions are now the proper instrument for bringing about this desirable end. He advances some intriguing reasons why even such union devices as the closed shop and the "checkoff" should be accepted as democratic methods of establishing "democracy in industry." Although this reasoning seems more plausible than convincing, it interprets the trend of thought of many sincere leaders and supporters of organized labor.

Engineers and managers honestly seeking to understand the viewpoint of conscientious labor leaders should find Dr. Myers' book exceptionally valuable.

[2] Personnel Director, Yale University, New Haven, Conn.

Books Received in Library

A.S.T.M. STANDARDS ON RUBBER PRODUCTS, prepared by Committee D-11, December, 1940. American Society for Testing Materials, Philadelphia, Pa. Paper, 6 × 9 in., 256 pp., illus., diagrams, charts, tables, $1.75. Thirty-four standard and tentative methods of test and specifications pertaining to rubber products are presented in convenient form for laboratory use and reference. The standards cover chemical analysis, physical properties, and various kinds of equipment. There is a nine-page bibliography of recent references on the mechanical testing of rubber.

ANALYTICAL MECHANICS FOR ENGINEERS. By F. B. Seely and N. E. Ensign. Third edition, rewritten. John Wiley & Sons, Inc., New York, N. Y., 1941. Cloth, 6 × 9 in., 450 pp., diagrams, charts, tables, $3.75. The principles of mechanics that are essential for engineers are presented in four parts: statics, kinematics, kinetics, and a group of special topics. The aim has been to present these principles clearly, to develop them from common experience, to apply them to concrete practical problems, and to emphasize their physical interpretations. A new chapter on mechanical vibrations and many new problems have been added in this edition.

AVIATION MECHANIC. By C. Norcross and J. D. Quinn. McGraw-Hill Book Co., Inc., Whittlesey House, New York, N. Y., 1941. Cloth, 6 × 9½ in., 563 pp., illus., diagrams, charts, tables, $3.50. Intended as a comprehensive course for the prospective airplane mechanic, this text presents first a simple exposition of aerodynamical theory. The very complete section on airplane construction includes a step-by-step description of the building of a light, all-metal airplane and of mass-production methods. Maintenance practice for all types of planes is explained in detail, and in this section, as well as the rest of the book, there is a wealth of practical illustrations. Tool requirements for the airplane mechanic are appended.

COMMERCIAL TIMBERS OF THE UNITED STATES. By H. P. Brown and A. J. Panshin. McGraw-Hill Book Co., Inc., New York, N. Y., 1940. Cloth, 6 × 9½ in., 554 pp., illus., diagrams, tables, $5. The first half of this comprehensive work is devoted to a full exposition of the structure of wood with special attention to identification features. Two keys are then given for the identification of the more important commercial woods of the United States, one based on characteristics visible to the naked eye and the hand lens, the other based on microscopic features. The descriptions by species record and explain important uses, and selected references are given. There is a glossary.

CROSBY-FISKE-FORSTER HANDBOOK OF FIRE PROTECTION, edited by R. S. Moulton. Ninth edition. National Fire Protection Association, Boston, Mass., 1941. Leather, 4½ × 7 in., 1308 pp., illus., diagrams, charts, tables, $4.50. This comprehensive manual contains essential information on all phases of fire prevention and fire protection. All new developments, during the five years since the last edition, in hazards, protective equipment, and methods have been included in this revision, to continue the policy of providing an authoritative review of accepted practice.

DEUTSCHE KRAFTFAHRTFORSCHUNG. Heft 43. Die zweckmässige Vorspannung in Schraubenverbindungen, by A. Thum and M. Würges. 20 pp. Heft 44. Die Fahrlage des Kraftwagens in der Kurve, by O. Dietz and R. Harling; Die Fahrtrichtungsstabilität des schnellfahrenden Kraftwagens, by L. Huber. 64 pp.

Heft 46. Zerspanbarkeit beim Stossen von Chrom-Molybdän-Baustählen, by H. Opitz and G. Zipp. 15 pp. V.D.I.-Verlag, Berlin, 1940. Paper, 8½ × 12 in., illus., diagrams, charts, tables, paper, 2.25 rm. each. The following topics are covered in these three German reports on automotive research: (43) Suitable initial stresses for bolted joints; (44) two papers dealing with the behavior of automobiles on curves under various conditions; (46) machinability of chromium-molybdenum structural steels in shaping practice, with emphasis on surface condition.

EISEN- UND STAHLLEGIERUNGEN Patentsammlung, 2. Ergänzungsband, 1. Teil, zugleich Anhang zur Metallurgie des Eisens in GMELINS HANDBUCH DER ANORGANISCHEN CHEMIE. By A. Grutzner and B. Habbel. Eighth revised edition, edited by Deutsche Chemische Gesellschaft. Verlag Chemie, Berlin, Germany, 1940. Cardboard, 7 × 10 in., 623 pp., tables, 47.25 rm in U.S.A. This volume contains a table of the patents for iron and steel alloys which were issued between January, 1935, and March, 1938, and is a supplement to two previous volumes on the subject. In addition to covering patents issued by the United States, Germany, England, France, Austria, and Switzerland as formerly there are also included patents from various other countries. The patents are grouped by alloys, and the information covers the composition, properties and uses, and the name of the patentee.

FOURIER SERIES AND BOUNDARY VALUE PROBLEMS. By R. V. Churchill. McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1941. Cloth, 6 × 9 in., 206 pp., diagrams, tables, $2.50. This book presents an introductory treatment of Fourier series and their application to the solution of boundary-value problems in the partial-differential equations of physics and engineering. The aim is to give the student a conception of orthogonal sets of functions and their use in the classical process of solving these problems. References and review problems are included.

GEFÜGE-RICHTREIHEN IM DIENSTE DER WERKSTOFFPRÜFUNG IN DER STAHLVERARBEITENDEN INDUSTRIE. (Berichte über betriebswissenschaftliche Arbeiten, Band 13.) By H. Diergarten. V.D.I.-Verlag, G.m.b.H., Berlin, Germany, 1940. Paper, 8 × 12 in., 53 pp., illus., diagrams, charts, tables, 16.50 rm. A method for evaluating iron and steel for various purposes by microscopic examination is described, in which comparison is made with standardized photographs. Several graduated series of varying forms of slag inclusion, carbide segregation, structure, and surface condition are furnished for comparison, in the form of loose plates. There is a bibliography.

Great Britain. Home Office (Air Raid Precautions Department). Air Raid Precautions Handbook No. 5A, First edition, BOMB RESISTING SHELTERS. His Majesty's Stationery Office, London, England, 1939. Paper, 8 × 13½ in., 6 pp., diagrams (obtainable from British Library of Information, New York, N. Y., $0.15). This pamphlet contains the recommendations of a defense committee with regard to structures which would afford protection against direct or near hits by heavy bombs. Designs are presented in accordance with these recommendations.

Great Britain. Home Office (Air Raid Precautions Department). Air Raid Precautions Memorandum No. 10, First edition, PROVISION OF AIR RAID SHELTERS IN BASEMENTS. His Majesty's Stationery Office, London, England, 1940. Paper, 6 × 10 in., 38 pp., diagrams, tables (obtainable from British Library of Information, New York, N. Y., $0.10). Rules are given for the number of persons to be accommodated, the degree of protection recommended, and for strengthening floors above basements to support debris loads. The greater part of the pamphlet, part IV, describes the provision of shelters in basements, with examples of methods which can be used in buildings of the domestic type.

Great Britain. Office of the Lord Privy Seal. AIR RAID SHELTERS, Report of the Lord Privy Seal's Conference, 1939 (reprinted 1940). His Majesty's Stationery Office, London, England. Paper, 6 × 9½ in., 26 pp. (obtainable from British Library of Information, New York, N. Y., $0.15).

Great Britain. Statutory Rules and Orders, 1939, No. 920. AIR RAID SHELTERS FOR PERSONS WORKING IN FACTORIES, MINES, AND COMMERCIAL BUILDINGS. Revised Code, August, 1939 (Section 13 of the Civil Defense Act, 1939). His Majesty's Stationery Office, London, England, 1940. Paper, 26 pp., 6 × 9½ in. (obtainable from British Library of Information, New York, N. Y., $0.15). All phases of the protective measures to be taken on behalf of the civil population are discussed briefly in this conference report, with emphasis on shelters. The revised Civil Defense Code is for the guidance of occupiers and owners of factory premises, factories, mines, and commercial buildings, and of other persons concerned. Requirements are stated and described, both for the shelters and means of access to them.

HANDBOOK OF THE GLASS INDUSTRY. Compiled and edited by S. R. Scholes. Ogden-Watney Publishers, New York, N. Y., 1941. Cloth, 6 × 9 in., 209 pp., diagrams, charts, tables, $5. This reference manual for the factory engineer, chemist, and plant executive provides practical information on raw materials, glasshouse fuels, compressed air, properties of glasses, furnaces, pyrometers, and ware defects. Extensive use of graphs and tables increases its ready-reference value. Necessary related data are included, and there is a glossary of glasshouse terms.

METALLURGY OF DEEP DRAWING AND PRESSING. By J. D. Jevons, with a foreword by H. W. Swift. John Wiley & Sons, Inc., New York, N. Y., 1940. Cloth, 6 × 10 in., 699 pp., illus., diagrams, charts, tables, $10. This comprehensive work covers the many phases of the subject in such a way as to be of value for both practical workers and scientific students. The author first describes the production of brass and steel sheet, including the metallurgical considerations. The defects and difficulties met in deep-drawing brass, steel, and other metals are discussed in detail, and the mechanical equipment is described. Test methods, material specifications, new applications, and desired improvements in metals and methods occupy separate chapters. There is a large list of references.

PETROLEUM INDUSTRY, an Economic Survey. By R. B. Shuman. University of Oklahoma Press, Norman, Okla., 1940. Cloth, 6 × 9 in., 297 pp., tables, maps, charts, $3. All phases of the petroleum industry are discussed from the viewpoint of an industrial enterprise. The technological subjects of production and refining, transportation, and storage are tied in with considerations of marketing practice, investment, and financial policies, taxation, etc. Labor relations and international trade are covered briefly, and a considerable chapter is devoted to questions of conservation and control. Much information is condensed into tables and diagrams. A bibliography is appended.

PRACTICAL METALLURGY. By G. Sachs and K. R. Van Horn. American Society for Metals, Cleveland, Ohio, 1940. Cloth, 6 × 9½ in., 567 pp., illus., diagrams, charts, tables, $5. This book presents concisely both the theory and practice of making, shaping, and heat-treating the commercial metals and alloys. In addition, the physicochemical and physical relationships of metallurgy are discussed in a fundamental, but simple way. Some fifteen hundred footnote references provide means for going more deeply into any particular topic. A large number of binary alloy constitutional diagrams are assembled in an appendix.

PRACTICAL SOLUTION OF TORSIONAL VIBRATION PROBLEMS, Vol. 1. By W. K. Wilson. Second edition. John Wiley & Sons, Inc., New York, N. Y., 1940. Cloth, 5½ × 9 in., 731 pp., illus., diagrams, charts, tables, $8. The principles and computation details of torsional vibration are presented in a manner suitable for everyday reference. The extensive revision and enlargement of the new edition necessitated two volumes, of which this first volume covers general principles, natural-frequency calculations, equivalent oscillating systems, flexible couplings, geared systems, and the determination of stresses at nonresonant speeds. An appendix gives an analysis of aero-engine air-screw systems; and numerous worked-out examples from marine, automobile, and aeronautical-engineering practice appear in the text. There is a bibliography.

PRESSWORKING OF METALS. By C. W. Hinman. McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1941. Cloth, 6 × 9½ in., 443 pp., illus., diagrams, charts, tables, $4. Practical applications of the principles used in the design of punches and dies are described and illustrated in this reference manual. The book demonstrates the selection and use of all types of presses, explains the selection and handling of materials, covers the physical properties of metals for strip and sheets, and shows the principles of die problems upon which tool designs are based. The necessary mathematics for press-tool design is presented in the last chapter.

SENIORITY POLICIES AND PROCEDURES AS DEVELOPED THROUGH COLLECTIVE BARGAINING. By F. H. Harbison. Princeton University, Industrial Relations Section, Princeton, N. J. 1941. Paper, 7 × 10 in., 63 pp., charts, tables, $1. The problem of seniority in employment is discussed with special reference to its importance in the national-defense program. This third report on the subject covers acquisition of rights, application methods, administration of seniority systems, and the importance of the question in union-management negotiations.

SOCIAL RELATIONS OF SCIENCE. By J. G. Crowther. The Macmillan Co., New York, N. Y., 1941. Cloth, 5½ × 8½ in., 665 pp., diagrams, $3.50. The progress of civilization is examined in order to determine the part played by science. The author discusses the reasons for the existence of the scientific attitude, the contributions to everyday life resulting from scientific methods, the position of the scientist in the present social scheme, and the interrelations between society and science through the ages. He concludes with suggestions for creating an effective social policy for science. References accompany many chapters.

TEMPERATURE; ITS MEASUREMENT AND CONTROL IN SCIENCE AND INDUSTRY. Papers presented at a Symposium held in New York City, November, 1939, under the auspices of the American Institute of Physics with the co-

operation of the National Bureau of Standards and National Research Council. Reinhold Publishing Corporation, New York, N. Y., 1941. Cloth, 6 × 9½ in., 1362 pp., illus., diagrams, charts, tables, maps, $11. One hundred and twenty-five papers by eminent engineers, metallurgists, physicists, physicians, and biologists are collected in this symposium. It presents thorough descriptions of all phases of temperature technique and theoretical treatment of the thermodynamics and physics which underlie the various temperature scales. The whole measurable range of temperature comes within the scope of the book, including such topics as low-temperature cancer therapy, cooling of concrete structures, high-temperature arcs, and molten-steel pyrometry. Particularly full bibliographies accompany most of the papers. An appendix contains useful tables of data and a brief glossary of technical terms.

THERMODYNAMICS. By H. A. Everett. Second edition. D. Van Nostrand Co., Inc., New York, N. Y., 1941. Cloth, 6 × 9½ in., 466 pp., diagrams, charts, tables, $3.75. This college textbook covers thoroughly the fundamentals of the subject in accordance with the author's experience as a teacher. Various phases are discussed in the light of modern developments in the field, the most recent of which have been incorporated in the new edition.

THOMAS' REGISTER OF AMERICAN MANUFACTURERS, Thirty-first edition, December, 1940. Thomas Publishing Co., New York, N. Y., Boston, Mass., Philadelphia, Pa., San Francisco, Calif., Toronto, Canada, 1941. Cloth, 9 × 14½ in., 5000 pp., illus., $10 to former subscribers, $15 to new subscribers. This huge annual directory of American manufacturers has its customary three main sections: The classified directory of products (with index) in which the firms are listed, with capital ratings, geographically under each product; the alphabetical list of manufacturers, giving addresses, subsidiaries, branches, etc.; and the trade-name index. The innovation, introduced in the previous edition, of assigning arbitrary numbers to advertisers, including a "key" index, has been expanded in the present volume.

TRENDS IN INDUSTRIAL PENSIONS. (Industrial Relations Monograph No. 5.) By M. W. Latimer and K. Tufel. Industrial Relations Counselors, New York, N. Y., 1940. Paper, 6 × 9½ in., 88 pp., tables, $1. The objectives of this monograph, which analyzes some 350 active company pension plans, are: First, to determine whether the characteristics and trends of pension systems have changed in the last seven years, and, if so, in what direction; second, to analyze the growth or decline and the present extent of the voluntary pension movement; and third, to consider the adaptation of private pension systems to governmental old-age insurance legislation. The numerical findings of the investigation appear in a group of tables.

WELDING METALLURGY. Vols. 1 and 2. By O. H. Henry and G. E. Claussen. American Welding Society, New York, N. Y., 1940. Cloth, 5 × 8 in., 359 pp., illus., diagrams, charts, tables, $1.50. Intended to familiarize members of the welding industries, including fabricators and designers, with the metallurgical aspects of the welding process, this book deals with the structure, properties, and composition of welded materials. It shows how the steel is affected by varied conditions of heat and stress, explains heat-treatment procedure and points out the way in which metallurgy can be used to control the welding process.

A.S.M.E. BOILER CODE

Interpretations

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Anyone desiring information on the application of the Code is requested to communicate with the Secretary of the Committee, 29 West 39th St., New York, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are then sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and is passed upon at a regular meeting of the Committee.

This interpretation is later submitted to the Council of The American Society of Mechanical Engineers for approval after which it is issued to the inquirer and also published in MECHANICAL ENGINEERING.

Following is a record of the interpretations of this Committee formulated at the meeting of February 14, 1941, which were subsequently approved by the Council of The American Society of Mechanical Engineers.

CASE No. 920

(Interpretation of Par. P-251)

Inquiry: Par. P-251 provides for the usual methods by which the ends of tubes are attached to drums in water-tube boilers. May tube ends or weld necks be attached by fusion welding, and the tubes welded thereto under the provisions of Par. P-112?

Reply: It is the opinion of the Committee that the intent of the Code will be met if such tube ends or weld necks are fusion-welded to the drums without expanding and flaring, provided the materials and welding comply with Pars. P-101 to 110, inclusive, and the connections comply with Par. P-268. The tubes may be welded thereto in accordance with Par. P-112.

CASE No. 921

(Special Ruling)

Inquiry: A clarification of Par. U-12(*c*) is requested. It is difficult to obtain pipe material or material for small parts and in small lots with mill test reports or certificates. Some provision should be made for the use of such unidentified material, if it can be proved to be of good weldable quality.

Reply: It is the opinion of the Committee that cast, forged, or rolled parts of small size for which it is difficult or impossible to obtain identified material, or which may be stocked and for which mill test reports or certificates cannot be economically obtained and are not customarily furnished, may be used for relatively unimportant parts or parts stressed to not more than 50 per cent of the stresses permitted by the Code, which do not appreciably affect the safety of the vessel, provided they are suitable for the purpose intended and meet the approval of the inspector.

CASE No. 922

(Interpretation of Par. P-299)

Inquiry: (*a*) In applying the quality factors to the allowable stresses for castings, in accordance with the footnote in Table P-7, is it permissible to use a quality factor of 100 per cent at the cylindrical ends of cast-steel welding end valves and fittings, in order to provide equal thicknesses for welding, provided these areas are machined both inside and outside and carefully inspected?

(*b*) Is it necessary to apply the casting quality factors of Table P-7 to American Standard flanged fittings (ASA B16e) for which dimensions and ratings are given in the Code?

Reply: (*a*) It is the opinion of the Committee that in order to provide equal thicknesses for welding, the cylindrical ends of cast steel welding end valves and fittings may be proportioned with a quality factor of 100 per cent, provided these areas are finish-machined both inside and outside and carefully inspected. In no case, however, shall the thickness of the ends be less than that of the adjoining pipe. The machined ends shall be tapered on a 1:4 maximum slope for a distance measured from the center of the weld of approximately 1½ times the pipe wall thickness. The remaining tapered section may be cast or machined on a 45-deg maximum angle.

(*b*) It is the opinion of the Committee that the casting quality factors of Table P-7 need not be applied to American Standard flanged fittings (ASA B16e) whose dimensions and ratings are incorporated in the Code.

Revisions and Addenda to Boiler Construction Code

IT IS the policy of the Boiler Code Committee to receive and consider as promptly as possible any desired revision of the rules and its code. Any suggestions for revisions or modifications that are approved by the Committee will be recommended for addenda to the code, to be included later in the proper place in the code.

The following proposed revisions have been approved for publication as proposed addenda to the code. They are published below with the corresponding paragraph numbers to identify their locations in the various sections of the code, and are submitted for criticism and approval from anyone interested therein. It is to be noted that a proposed revision of the code should not be considered final until formally adopted by the Council of the Society and issued as pink-colored addenda sheets. Added words are printed in SMALL CAPITALS; words to be deleted are enclosed in brackets [ ]. Communications should be addressed to Secretary of the Boiler Code Committee, 29 West 39th St., New York, N. Y., in order that they may be presented to the Committee for consideration.

PAR. P-16. Revise values for shear strength of steel rivets as follows:

Steel rivets, SPEC. S-5, GRADE A, in single shear	44,000
Steel rivets, SPEC. S-5, GRADE A, in double shear	88,000
STEEL RIVETS, SPEC. S-5, GRADE B, IN SINGLE SHEAR	52,000
STEEL RIVETS, SPEC. S-5, GRADE B, IN DOUBLE SHEAR	104,000

PAR. P-112 (*a*). Add the following as (6):

(6) Pipe or tubes and superheater headers exceeding the dimensions given in (1), (2), and (3) above, may be fusion-welded under the requirements of this paragraph, provided the welded joints are radiographed and meet the requirements of Par. P-102 (*b*).

PAR. P-200. Add the following:

Flexible type stay bolts having a cover cap welded, under the provisions of Par. P-112, to the outer sheet may be used in the construction of locomotive-type boilers provided the bolts are hollow drilled from the threaded end into and partly through the ball head to allow for proper inspection, and so that any breakage is disclosed by leakage at the inner end. These welded joints need not be stress-relieved or X-rayed.

PAR. P-268 (*e*). Revise first sentence of second section to read:

All welding for fusion-welded connections shall be equivalent to that required under the rules in Pars. P-101 to P-111, inclusive, OR THE RULES IN PAR. P-112.

PAR. P-299 (*e*). Add the following:

When the service requirements exceed the permissible values of the American Standard, the requirements of the Code will be met if the bolting material, flange, and/or body thicknesses are increased to keep the same deflection limits and the same factor of safety as required by the nearest American Standard.

PAR. P-300. Add the following to the fourth section:

Where the piping is furnished and erected by other than the boiler manufacturer, each contractor for the piping shall furnish a data report form number P-2 or P-3 covering the shop and field assembly inspections.

PAR. A-20 (*b*). Revise second section to read:

Fusible plugs which comply with the Rules and Regulations of the U. S. Bureau of Marine Inspection and Navigation WILL BE CONSIDERED TO COMPLY WITH THE REQUIREMENTS OF PARS. A-19 AND A-20 AND may have the letters "A.S.M.E." stamped on the casing instead of on the fusible metal.

SPECIFICATION S-13. Par. 3. Add the following:

Class	Tensile strength min, lb per sq in.
No. 25	25,000
No. 35	35,000

Par. 4 (*a*). Add the following:

Class	Test Bar *A* 0.875 in. diam 12-in. supports	Test Bar *B* 1.2-in. diam 18-in. supports	Test Bar *C* 2.0-in. diam 24-in. supports
25	1025	2000	6800
35	1275	2400	8300

A.S.T.M. Spec. A176-39 for Corrosion-Resisting Chromium Steels (Sheets, Flats, Strip), grades 2, 4, and 6 to be incorporated in Section II of the Code as Specification S-61.

PAR. L-3. Add a reference to "S-53."

PAR. U-1 (*a*). Replace by the following:

(*a*) The rules of this section are not intended to apply to the following vessels:

(1) Vessels having a cubical content of 5 cu ft or less in which the working pressure does not exceed 250 lb per sq in.;

(2) Vessels having a cubical content of $1\frac{1}{2}$ cu ft or less in which the working pressure exceeds 250 lb per sq in.;

(3) Vessels of any volume in which the working pressure (internal or external) is 15 lb per sq in. or less.

Vessels below these limits may be stamped as provided in Par. U-66 (*d*).

PAR. U-13 (*e*). Add the following:

Open-hearth steel pipe or steel tubing in accordance with one of the following specifications may be used for the pressure part of an unfired pressure vessel provided the nominal diameter of the pipe or tubing is not greater than 18 in.:

S-17 Specifications for Lap-Welded Seamless and Lap-Welded Iron Boiler Tubes

S-18 Specifications for Welded and Seamless Steel Pipe

S-19 Specifications for Welded Wrought-Iron Pipe

S-32 Specifications for Electric-Resistance-Welded Steel and Open-Hearth Iron Boiler Tubes

S-40 Specifications for Seamless Steel Boiler Tubes for High-Pressure Service

S-45 Specifications for Seamless Carbon Molybdenum Alloy-Steel Pipe for Service at Temperatures From 750 to 1000 F

S-48 Specifications for Seamless Carbon-Molybdenum Alloy-Steel Boiler and Superheater Tubes

S-49 Specifications for Medium-Carbon Seamless Steel Boiler and Superheater Tubes

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TABLES P-7 AND U-2. Add the following:

Spec. No.	Grade	Spec., Min Tens.	Notes and Limitations	—20 to 650	700	750	800	850	900	950	1000
S-58 (A135-34)	A	48,000	(3) (4)	9400	9000	8600	7900	6800	5600	3800	2000
S-58 (A135-34)	A	48,000	(4)	9400	9000	8600	7150	5850	4400	2600	..
S-58 (A135-34)	B	60,000	(3) (4)	12,000	12,000	10,400	9100	7400	5600	3800	2000
S-58 (A135-34)	B	60,000	(4)	12,000	12,000	10,400	8300	6350	4400	2600	..

TABLE P-5. Add the following:

Spec. No.	Grade	Min Tensile Strength	Min Silicon	S Values
S-58 (A135-34)	A	48,000	(3) (4)	Same as S-32A (3) (4)
S-58 (A135-34)	A	48,000	(4)	Same as S-32A
S-58 (A135-34)	B	60,000	(3) (4)	Same as S-32C (4)
S-58 (A135-34)	B	60,000	(4)	Same as S-32C

S-58 Specifications for Electric-Resistance-Welded Steel Pipe

PAR. U-20 (*a*). Add the following after the definition R:

When a shell is made of any of the welded tubing or piping enumerated in Par. U-13 (*e*), the factor *S E* shall be as given in Table U-2 (*a*).

PAR. U-20 (*a*). Insert wording of Par. P-180 (*b*) as item (2) of Par. U-20 (*a*).

PAR. U-59 (*p*). Revise to read:

(*p*) When vessels are built in accordance with Par. U-68 all connections after being attached by fusion welding shall be stress-relieved.

When vessels are built in accordance with Par U-69 and are required to be stress-relieved, all connections AND OTHER ATTACHMENTS after being attached by fusion welding shall also be stress-relieved. When vessels are built in accordance with Par. U-69 and are not required to be stress-relieved, [all] connections AND OTHER ATTACHMENTS after being attached by fusion welding NEED NOT [shall] be stress-relieved [except as follows:]

CAUTION: A WELDING PROCEDURE SHOULD BE USED WHICH WILL PREVENT EXCESSIVE LOCKED-UP STRESSES AND WARPAGE. A CERTAIN DEGREE OF PREHEATING PROVIDED EITHER BY THE WELDING ITSELF OR BY OTHER MEANS MAY BE NECESSARY IN SOME CASES.

[(1) Connections formed by welding a plain end pipe, welding neck, or nipple directly to the vessel without the attachment of additional material need not be stress-relieved where the pipe size is 3 in. or less, regardless of the diameter of the vessel. Such connections larger than 3 in. pipe size need not be stress-relieved provided the diameter of the opening does not exceed 10 per cent of the outside diameter of the shell. (Some such connections are illustrated in Fig. U-7 (*a*) and (*c*).)

(2) Connections formed by welding to such vessels an hydraulic coupling or special forging for a threaded opening not to exceed 3 in. pipe size.]

IF A VESSEL AS A WHOLE IS NOT REQUIRED TO BE STRESS-RELIEVED, BUT SOME PARTS, BECAUSE OF THICKNESS IF ANY WELDING IS DONE ON THEM, ARE REQUIRED TO BE STRESS-RELIEVED, THE PARTS MAY BE SO TREATED BEFORE BEING ATTACHED TO THE VESSEL.

When vessels are built in accordance with Par. U-70, connections AND OTHER WELDED-ON ATTACHMENTS [after being attached by fusion welding] need not be stress-relieved.

PAR. U-64. Add the following as (*c*):

(*c*) Vessels that are galvanized after fabrication may be hydrostatically tested after the galvanizing process.

PAR. U-66 (*a*). Revise second sentence of third section to read:

These markings shall be legibly stamped with letters and figures at least $^5/_{16}$ in. high on some conspicuous portion of the vessel, preferably near a manhole, if any, or handhole, [or on a name plate brazed or otherwise irremovably attached to the shell plate].

Replace the third section by the following:

Separate name plates may, and for vessels constructed of plate less than $^1/_4$ in. thick must, be used on which the data required by this paragraph, excepting the Code symbol and serial number, may be etched, cast, or impressed. Such plates shall be brazed or otherwise irremovably attached to the vessel in a conspicuous location.

The Code symbol and other required data not on the plate when made may be stamped on the plate prior to its being affixed to the vessel but the inspector shall see that the plate with the correct stamping is applied to the proper vessel.

The height of the letters and figures shall not be less than $^5/_{32}$ in. Any arrangement of the required items may be followed except that the Code symbol must be on the left side of the plate.

PAR. U-68 (*b*). Revise as follows:

(*b*) When a test plate is welded for the longitudinal joints, none need be furnished for circumferential joints OR NOZZLES in the same drum, providing the welding process, procedure, and technique are the same. Where a drum has only circumferential joints a test plate of the same material as the shell shall be welded in the same way as the joints in question.

WHEN A DRUM HAS NEITHER LONGITUDINAL NOR CIRCUMFERENTIAL JOINTS, NO TEST PLATE NEED BE FURNISHED FOR NOZZLES IF THEY ARE APPLIED BY WELDING OPERATORS QUALIFIED UNDER THE PROVISIONS OF PARS. UA-41 TO UA-53, INCLUSIVE. [When noncylindrical pressure parts are not integral with the drum or shell, a test plate, of a thickness not less than that of the parts, shall be provided.]

PAR. U-71. Revise second section by adding the following:

S-19 Specifications for Welded Wrought Iron Pipe

S-32 Specifications for Electric-Resistance-Welded Steel and Open-Hearth Iron Boiler Tubes

PAR. U-76 (*d*). Revise to read:

(*d*) All connections attached by fusion welding shall be stress-relieved on vessels requiring stress relief and as required by Par. U-59 (*p*), [or] (*q*), AND (R).

PAR. U-7 (*e*) (4). Revise to read:

(*e*) (4) Nozzles or OTHER welded attachments for which stress relief is required may be locally stress-relieved by heating a CIRCUMFERENTIAL BAND WITH THE CONNECTION AT THE MIDDLE OF THE BAND, THE BAND TO BE AT LEAST 12 TIMES THE SHELL THICKNESS WIDER THAN THE ATTACHMENT, IN SUCH A MANNER THAT THE ENTIRE BAND SHALL BE BROUGHT UP TO THE TEMPERATURE AND HELD FOR THE TIME SPECIFIED ABOVE FOR STRESS RELIEVING [circular area around the nozzle or attachment provided any part of the welded edge thereof is not less than $12t$ (t = thickness of plate) from the nearest adjacent welded joint or other element that would tend to restrict the free expansive movement of the heated area. The outside dimensions of this annular ring to be heated shall be at least $6t$ away from the outermost weld but not less than 5 in., and the entire area shall be heated simultaneously].

PAR. U-94. Revise to read:

U-94. When properly brazed the strength of a joint may be calculated on a maximum unit working stress of $S E = 90$ PER CENT OF THE MAXIMUM ALLOWABLE WORKING STRESSES SHOWN IN TABLE U-2 FOR THE MATERIALS PROVIDED FOR IN PAR. U-71 [9900 lb per sq in. (See Par. U-20)].

Table U-2 (*a*). Add the following new table:

TABLE U-2 (A) ALLOWABLE WORKING STRESSES ($S E$) IN FORMULA IN PAR. U-20 (A) FOR WELDED PIPE AND TUBES

Spec. No.	Material, grade	Weld	For temperatures not exceeding deg F: 650	700	750	800	850	900	950
S-17	Steel	Lap	7300	7000	6650	5550	4550	3400	2000
S-17	Wrought	Lap	5600	5300	4800	...	...	...	...
S-18	Steel	Lap	7300	7000	6650	5550	4550	3400	2000
S-18	Steel	Butt	5400	5300	5050	...	...	...	...
S-19	Wrought	Lap	5600	5300	4800	...	...	...	...
S-19	Wrought	Butt	4800	4600	4150	...	...	...	...
S-32	A Silicon 0.10 %	Resis.	8000	7650	7300	6700	5800	4750	3250
S-32	A	Resis.	8000	7650	7300	6100	5000	3750	2200
S-32	B	Resis.	6800	6500	5850	...	...	...	...
S-32	C Silicon 0.10 %	Resis.	10,200	10,200	8850	7750	6300	4750	3250
S-32	C	Resis.	10,200	10,200	8850	7050	5400	3750	2200
S-58	A Silicon 0.10%	Resis.	8000	7650	7300	6700	5800	4750	3250
S-58	A Silicon 0.10%	Resis.	8000	7650	7300	6100	5000	3750	2200
S-58	B Silicon 0.10%	Resis.	10,200	10,200	8850	7750	6300	4750	3250
S-58	B Silicon 0.10%	Resis.	10,200	10,200	8850	7050	5400	3750	2200

Fig. U-13. This illustration will be corrected to replace the "Weld Metal Tension Specimen" which was inadvertently omitted in the printing of the 1940 Edition.

Tables U-3 and P-6. In the proposed revision of these tables appearing in the March, 1941, issue of MECHANICAL ENGINEERING change "Subzero to 150" to read "150 (7);" add a new footnote (7) to read: "(7) The allowable stresses given may also be used for subzero temperatures." In footnote (5) add a sentence to read: "This is not intended to apply to valves and fittings made to a recognized standard."

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Kansas City, "Heart of America," Invites You to Semi-Annual Meeting of A.S.M.E.

Program Includes Wide Variety of Subjects, Authors of Renown, Timely Inspection Trips, and Delightful Social Events

KANSAS CITY, the "Heart of America," extends to all A.S.M.E. members a sincere invitation to attend the Semi-Annual Meeting. The time is Monday, June 16, through Thursday, June 19. Meetings will be held in the beautiful Hotel Muehlebach, where air-conditioned meeting rooms top the long list of aids to your comfort, provided for what is expected to be the finest Semi-Annual Meeting ever.

Last month's announcement in these pages clearly showed that the scope and detail of the program will be of wide interest. Technical sessions cover a great variety of subjects and authors of renown promise many an interesting and worth-while hour. Discussions should be keen and timely. Not least in attractiveness at this meeting will be Kansas City itself, a modest home of industry, commerce, art, and civic beauty. Relief from the tenseness of technical sessions can be had without difficulty; inspection trips have been arranged, golf courses are available, the Art Gallery is sure to attract many, and a drive through the Country Club district is sure to be a tonic.

Registration Fee for Non-Members at the 1941 Semi-Annual Meeting

There will be a registration fee of $2 for nonmembers attending the 1941 A.S.M.E. Semi-Annual Meeting. For nonmembers wishing to attend just one session the fee will be $1. This is in accordance with the ruling of the Standing Committee on Meetings and Program.

Members wishing to bring nonmember guests may avoid this fee by writing to the Secretary of the Society before June 6 asking for a guest-attendance card for the Semi-Annual Meeting. The card, upon presentation by a guest, will be accepted in lieu of the registration fee. Guests are limited to *two per member*.

Many Divisions Cooperate in Program

The Fuels Division will start with a discussion of Midwest fuels and will carry through with a series of papers covering new methods of production in strip mines, the preparation of nonslacking subbituminous and lignitic coals, and even the subject of colloidal fuels. The Materials Handling Division will cooperate with allied discussions.

The Heat Transfer Division, among other papers, will deal with vaporization inside of horizontal tubes. The Hydraulic Division will cover the water front from surge problems at Fort Peck to ice at Grand Coulee. The Management Division will provide discussions on the administrative organization of small industrial companies and other timely subjects.

The Petroleum Division sessions will provide up-to-date information on a wide variety of subjects—substitute motor fuels, various instrumentation problems, synthetic rubbers, oil-field equipment, and others of vital importance. The Power Division proposes to discuss both theory and fact in dealing with air heaters, turbogenerators, cooling towers, turbine lubrication, and kindred subjects including boiler-plant problems.

Two divisions intimately associated with industrial Kansas City are the Process Industries and Railroad Divisions. Yes, the former will certainly deal with flour mills—the particular subject being air conditioning. The Railroad Division, realizing that Kansas City is not only a railroad center, but also was the terminal of two of the first *Zephyr* and streamliner trains, will hear about "Steam Versus Diesel Locomotives," as well as discuss all types of motive power. Draft gears will be the theme of a second session.

E.C.P.D. Sessions Outstanding

Education assumes an important role in the 1941 Semi-Annual Meeting. Prize student papers for districts V, VI, and VII will be presented and "Student Activities" will be discussed. Defense training, a most timely subject, will receive adequate recognition. Of outstanding importance, the Engineers' Council for Professional Development presents its first major program at an engineering-society meeting. Promotion of the E.C.P.D. program through local A.S.M.E. Sections is the subject and detailed discussions—"terse and snappy, concrete and constructive"—will encompass the E.C.P.D. progress, accrediting, guidance, experiences, training for junior engineers, professional recognition, and teaching ethics.

"THE RENDEVOUS"

(Cocktail lounge at the Hotel Muehlebach, headquarters of the A.S.M.E. Semi-Annual Meeting in Kansas City, June 16–19.)

Such a well-rounded program is incentive enough to create an unusually large attendance. But more is available. Inspection trips definitely scheduled include, among others, the T.W.A. maintenance shops where all ships, including the Stratoliners, are serviced, the municipal auditorium whose appointments attract conventions from the smallest to the largest without taxing its facilities for service and comfort, the Sheffield Steel Mill, one of the world's outstanding strip coal mines, a refinery, and power plants.

Entertainment in Abundance

Relaxation and acquaintance with the arts are available for the asking. Golf and tennis can be had at several clubs and at the municipal course and courts. Dancing and refreshments are provided in the Hotel Muehlebach as well as at other hotels. Kansas City abounds in the arts. The Nelson Gallery is one of the country's finest and its permanent collection and its exhibits have created a nation-wide reputation for their high quality. The ad-

NIGHT VIEW OF MAGNIFICENT MUNICIPAL AUDITORIUM IN KANSAS CITY

jacent Art Institute is nationally known for its training courses in both pure and commercial art. The federal government is depending upon it for research in the art of camouflage.

The Country Club district with its homes, its clubs, its plaza shopping center, all so attractively individual, has long since been the goal to which others have pointed when civic planning and growth have been discussed. This truly unique part of greater Kansas City is worth visiting and studying. Its many beautiful vistas, magnificent homes, and works of art are truly inspirational. Lovers of yesteryear will enjoy the Kansas City Museum, the Shawnee Mission, and other spots of historical interest.

The ladies will be delighted with Kansas City—but Mrs. Kansas City, who signs herself anonymously as "Your Friends," has issued a special invitation to the gentler sex. This invitation appears directly below.

Kansas City invites you to enjoy the 1941 Semi-Annual Meeting—a truly memorable occasion.

To the Ladies!

Dear Mrs. A.S.M.E.:

Has your husband told you about the convention to be held in Kansas City, June 16–19? Are you planning to come? In case he has forgotten, or "forgotten"—you know what I mean!—this is a special invitation so you can begin working on him. You see, we really Want, with a capital W, you to come. The theory that a man has a better time at a convention when he knows the little woman is safe at home with Junior is outmoded and passé. So is the old argument that she wouldn't have a good time anyway, submerged by a horde of strangers.

Five Minutes—and Women Aren't Strangers!

We all know women aren't strangers after the first five minutes unless—Heaven forbid—we've lost our ability to discuss children, maids, diets, and operations. Or perhaps you prefer bridge, books, or badminton. It doesn't matter. There are always kindred spirits. Ask the woman who's been there.

Maybe he's afraid—though he probably won't come right out and say so—you'll be under foot when he wants to be with the boys. He needn't worry. Kansas City has beautiful, air-conditioned stores in case you're a make-every-minute-count person, or only a stroller. Two luncheons have been planned, one followed by bridge, either Culbertson or Chitchat rules as you will; the other by a drive through our astonishingly lovely and well-known residential section, a trip you will always remember. You'll want to see the wonderful Nelson Art Gallery with its new exhibit of European treasures, and have tea at The University Women's Club as our guest.

If you're bitten by the golfing bug, there are courses galore open to you for a small fee; or if life is real and earnest, there is the fascinating Kansas City Museum that will take you back to the days of the Covered Wagon and the Pony Express and the War Between the States, and the imposing Liberty Memorial with its display of more recent war relics and trophies. Are you a baseball fan? Perhaps—sh!—the Blues will be in town.

Country at Its Loveliest

Due to defense regulations, we can't promise you trips through some of our factories, food plants, and packing houses. But within an hour's drive of the city, through country that will be at its loveliest, you can still see occupied homes, complete with slave cabins, that were famous in the 1860's; or across the state line to the west, visit The Haskell Institute for Indians and The University of Kansas at Lawrence. If Mary Ann or Junior is in High School, you'll doubtless want to look over our new and rapidly growing University of Kansas City, twenty minutes from your hotel, and our excellent Art Institute. Or perhaps The Children's Mercy Hospital, with its marvelous charity work, will appeal to you. No, he needn't be anxious about having you in his hair.

Cotton Clothes Very Much in Order

As for clothes, don't let that bother you. We're a cotton-minded community after June first, with an occasional sheer thrown in to bolster our ego, and a light wrap for evening just in case. Of course there's the Wednesday night banquet when he'll want you to glow—men are pretty nice, aren't they?—and the Tuesday buffet supper, but that's informal. Hats are as crazy as ever, so last year's model needn't give you an inferiority complex. Dust it off and announce you're ready. He'll think you're wonderful, and bringing you along was the best idea he ever had.

So please, dear Mrs. A.S.M.E., arrange with your neighbor to keep the canary, and begin counting the days, as we are, till June 16. We'll be looking for you.

Most sincerely,
Your Friends.

Kansas City Convention Bureau

TEEING OFF IN SWOPE PARK
(One of several golf courses in Kansas City, Mo.)

Kansas City Convention Bureau

THE WILLIAM ROCKHILL NELSON GALLERY OF ART AND MARY ATKINS MUSEUM, KANSAS CITY, MO.

A.S.M.E. Semi-Annual Meeting Program

Kansas City, June 16-19, 1941

Headquarters, Hotel Muehlebach

MONDAY, JUNE 16

9:30 a.m.

Council Meeting

Education and Training—I

The Functions of a Design Engineer, by W. E. Johnson

A Suggested Design for Mechanical-Engineering Curricula, by F. L. Wilkinson

Qualifications for Operating Responsibility, by Alex D. Bailey

Fuels

Colloidal Fuel, by J. E. Hedrick

The Firing of Pulverized Coal and Other Fuels Together, by A. C. Foster

Petroleum

Motor Fuels and Their Substitutes, by Gustave Egloff

Calculation of Critical Speeds in Oil-Well Pumping Systems, by C. R. Freberg and E. N. Kemler

Official Notice

A.S.M.E. Business Meeting

THE semi-annual business meeting of the members of The American Society of Mechanical Engineers will be held Monday afternoon, June 16, 1941, at 2:00 p.m. in the Hotel Muehlebach in Kansas City, Mo., as a part of the Semi-Annual Meeting of the Society

(*Signed*) C. E. DAVIES
Secretary

Sucker Rod Pumping, by S. B. Sargent, Jr., and R. W. Rieniets

Process Industries

Experimental Studies of Automatic Control, by J. C. Peters

Air Conditioning in the Flour Mill, by George M. Sebree

2:00 p.m.

Business Meeting

8:00 p.m.

Power

Experiences at Des Moines With Large Condensing 3600-Rpm, Turbogenerator and Accompanying Boilers, by J. F. McLaughlin

Some Air-Heater Facts, 1926 to 1941, by E. L. Hopping and D. F. Schick, Jr.

TUESDAY, JUNE 17

9:30 a.m.

E.C.P.D.—I

Interrelations of A.S.M.E. and E.C.P.D., by C. F. Scott

Accrediting—Present Status, by A. A. Potter

How Can A.S.M.E. Local Activities Promote the E.C.P.D. Program in Selection and Guidance (in high schools)

Introductory Statement, by R. L. Sackett

City Organization and Guidance, by Frank H. Prouty

State Engineering Society Guidance, by J. S. Dodds

Experience With Student Selection and Guidance in Kansas, by M. A. Durland

Experience in High-School Vocational Guidance in Kansas City, by F. J. Holzbaur

Fuels

Hand-Fired Smokeless Furnace, by Julian R. Fellows and John C. Miles

Some Recent Chain-Grate-Stoker Installations, by F. X. Gilg

Hydraulic—I

Ice Prevention by the Air-Lift System at Grand Coulee, by T. C. Owen

Developments in Regulating Outlet Valves, by G. J. Hornsby

Petroleum

The Development of Steels and Alloys for Use at Elevated Temperatures in Petroleum Refineries as Still Tubes, Furnace Supports, and Other Parts, by B. B. Morton

Calibration of Displacement Meters on Volatile-Liquid Petroleum Fractions, by E. W. Jacobson

Power

Cooling-Tower Progress, by L. T. Mart

Stability Characteristics of Turbine Oils, by L. C. Welch

Welding of Boiler Tubes, by F. C. Hutchison

Railroad—I

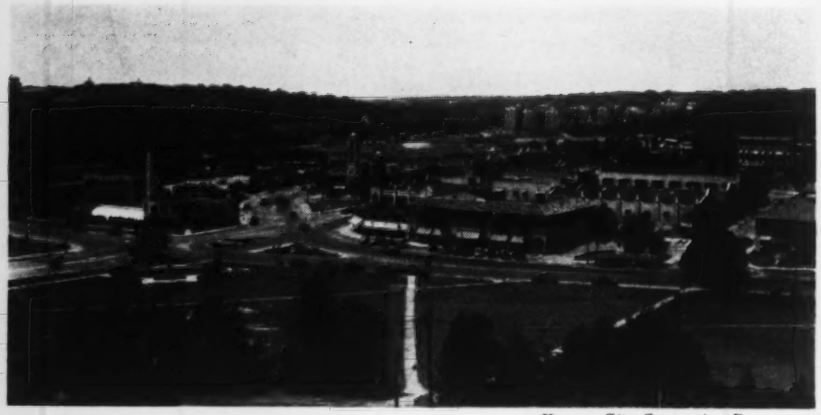
Comparison of Operation of Steam Versus Diesel-Electric Locomotives in Railroad Service, by E. E. Chapman

Modern Steam Passenger Locomotive—Research and Design, by P. W. Kiefer

Utilization of Steam Passenger Locomotives, by A. A. Raymond

The Modern Steam Locomotive in Freight Service, by C. E. Pond

(*Program continued on following page*)



Kansas City Convention Bureau

GENERAL VIEW COUNTRY CLUB PLAZA

(One of several shopping centers which serve the Country Club residential section in Kansas City, Mo.)

2:00 p.m.

Railroad—II

Electric-Locomotive Operation, by H. C. Griffith

Advance in Locomotive Tender Design, by Otto Jabelmann

8:00 p.m.

E.C.P.D.—II

E.C.P.D., Past, Present, and Future, by C. F. Scott

How Can A.S.M.E. Local Activities Promote E.C.P.D. Program in Professional Training of Junior Engineers

Professional Training, by S. K. Kirkpatrick

Cooperative Interests Between Corporate Members of the Society, Students, and Junior Members, by Roy M. Green

Discussion—Past Activities and Future Plans

WEDNESDAY, JUNE 18

9:30 a.m.

Education and Training—II

(National Defense)

Training to Meet the National Emergency, by O. H. Day

Hydraulic—II

Fort Peck Surge Problem, by F. H. Littrell

Piston Effect of Trains in Tunnels, by R. L. Daugherty

Management

Administrative Organization for a Small Manufacturing Company, by Willis Rabbe

Selection of Subordinate Personnel, by H. C. Taylor

Petroleum

Liquefaction and Regasification of Lighter Hydrocarbons, by H. C. Cooper

Instruments for Determining Subsurface Conditions in Oil Wells, by P. G. Exline

Power

Steam-Turbine Regenerative Cycle and Analytical Approach, by J. K. Salisbury

Functions and Requirements of Steam-Turbine Control Systems, by A. F. Schwendner

2:00 p. m.

Heat Transfer

Vaporization Inside of Horizontal Tubes—II, by W. H. McAdams, W. K. Woods, and R. L. Bryan

A Method of Determining Pressure Drop for Oil-Vapor Mixtures Flowing Through Furnace Coils, by F. W. Dittus and A. Hilderbrand

Materials Handling

(Jointly with Fuels Division)

Coal-Handling Systems for Central Stations, by George Daniels

Handling Dust and Fly Ash in Power Plants, by Elmer L. Hughes

THURSDAY, JUNE 19

9:30 a.m.

Fuels

Recent Developments in Midwest Strip Mining, by C. Y. Thomas

The Preparation of Stable Nonslacking Fuel by Steam-Drying Subbituminous Coal and Lignite, by V. F. Parry, L. C. Harrington, and Arthur Koth

Petroleum

Measurement of Properties of Natural Hydrocarbon Systems at Reservoir Pressures and Temperatures, by Kenneth Eilerts

Manufacture of Synthetic Rubber From Petroleum Products, by J. H. Boyd, Jr.

Student-Branch Session

(Jointly with E.C.P.D.)

Three Student Prize Papers

The Student Branch Looks Forward to Professional Status

The General Situation, by C. F. Scott

How I Present the Engineering Profession to My Students, by W. R. Chedsey

Preliminary Report on Teaching Ethics, by C. E. Davies

Comments on Report

General Discussion

A.S.M.E. Oil and Gas Power Division to Hold National Meeting at Kansas City, June 11–14

Engineering Quiz a Feature

THE National Meeting of the Oil and Gas Power Division of the A.S.M.E., to be held at Kansas City, June 11 to 14, will feature an engineering quiz. Under the guidance of C. G. A. Rosen, Caterpillar Tractor Co., several experts will attempt to answer questions on Diesel and gas engines, submitted by anyone who has a pet problem.

Prizes will be awarded those whose questions confound the experts. These questions should be mailed to Glenn Boyer, Burns & McDonnell Engineering Co., Linwood Boulevard, Kansas City, Mo.

At other sessions of this meeting there will be papers on: (1) engine foundations; (2) automatic protective devices; (3) connecting-rod-bolt failures; (4) aviation Diesels; (5) sewage-gas engines; (6) inspection instruments and procedure; (7) Diesel insurance; (8) chrome plating of liners; (9) supercharging Diesels; and (10) centrifuging of fuel and lubricating oil.

A.S.M.E. Calendar

of Coming Meetings

May 2, 1941
National Defense Meeting
Pittsburgh, Pa.

June 11–14, 1941
Oil and Gas Power Division
Kansas City, Mo.

June 16–19, 1941
Semi-Annual Meeting
Kansas City, Mo.

June 20–21, 1941
Applied Mechanics Division
University of Pennsylvania
Philadelphia, Pa.

October 12–15, 1941
Fall Meeting
Louisville, Ky.

October 30–31, 1941
Joint Meeting of A.S.M.E. Fuels and A.I.M.E. Coal Divisions
Lafayette College
Easton, Pa.

December 1–5, 1941
Annual Meeting
New York,
N. Y.

(For coming meetings of other organizations see page 22 of the advertising section of this issue)

A.S.M.E. National Applied-Mechanics Meeting, Philadelphia, June 20-21

Enlists Cooperation of A.S.M.E. Heat Transfer Division and A.S.C.E. Committee on Applied Mechanics

THE eighth national meeting of the Applied Mechanics Division of the A.S.M.E. will be held on the campus of the University of Pennsylvania with the cooperation of the Heat Transfer Division of the A.S.M.E. and the Committee on Applied Mechanics of the Structural Division of the American Society of Civil Engineers under the auspices of the University of Pennsylvania and the Philadelphia Section of the A.S.M.E. on June 20 and 21. The technical program includes papers from all of the cooperating groups.

Dinner at Old Bookbinder's

A dinner will be held on the evening of June 20 at Old Bookbinder's, famous Philadelphia restaurant, at which D. Robert Yarnall, Fellow A.S.M.E., vice-president of the American Friends' Service Committee, will speak on "My Impressions of England at War as I Saw It in January, February, and March."

Four technical sessions will be held as follows:

Heat Transfer, Fluid Mechanics, and Thermodynamics

(Jointly with Heat Transfer Division)

The Effect of Variable Viscosity on the Compressibility Boundary-Layer Flow Around a Flat Plate, by H. W. Emmons and J. G. Brainerd, University of Pennsylvania

A Method for Determining Unsteady-State Heat Transfer by Means of an Electrical Analogy, by V. Paschkis and H. D. Baker, Columbia University

The Effect of Departures From Dalton's Law on the Determination of Latent Heat by the Gas Current Method, by J. A. Goff and J. H. Hunter, University of Pennsylvania

Steady Flow in the Transition Length of a Cylindrical Conduit, by H. L. Langhaar, Purdue University

Elasticity and Plasticity

Two Problems of Thermal Stress in the Infinite Solid, by N. O. Myklestad, Illinois Institute of Technology

The Circular Cylinder With a Band of Uniform Pressure on a Finite Length of the Surface, by M. V. Barton, Cornell University

Buckling of the Circular Plate Beyond the Critical Thrust, by R. O. Friedrichs and J. J. Stoker, New York University

An Extension of the Sand-Heap Analogy in Plastic Torsion Applicable to Cross Sections Having One or More Holes, by M. A. Sadowski, Illinois Institute of Technology

Vibrations

The Analysis of Longitudinal Motions in Trains of Several Cars, by W. M. Dudley, Case School of Applied Science

Dampers of Turbine Blades, by C. A. Meyer and H. B. Saldin, Westinghouse Electric and Manufacturing Co.

Self-Excited Oscillations in Dynamical Systems Possessing Retarded Action, by N. Minorsky, U. S. Navy

Elasticity and Plasticity

(Jointly with A.S.C.E. Committee on Applied Mechanics)

A Numerical Procedure for the Calculation of Deflections and Moments in Beams and Columns, by N. M. Newmark, University of Illinois

Action of Deep Beams Under Combined Vertical, Lateral, and Torsional Loads, by C. O. Dohrenwend, University of Connecticut

The Lateral Buckling of the I-Section Column With Eccentric End Loads in the Plane of the Web, by Bruce G. Johnston, Lehigh University

The Mechanics of Creep in the Case of Statically Indeterminate Structures, by Joseph Marin, Illinois Institute of Technology

Officers of Cooperating Groups

The officers of the A.S.M.E. Applied Mechanics Division are J. P. Den Hartog, chairman, and H. L. Dryden, secretary; of the A.S.M.E. Heat Transfer Division, E. D. Grimison, chairman, and W. S. Patterson, secretary; of the A.S.C.E. Committee on Applied Mechanics, E. L. Eriksen, chairman, and R. D. Mindlin, secretary. J. S. Morehouse is chairman of the Philadelphia Section of the A.S.M.E. The local committee is headed by C. H. Coogan for the men and Mrs. J. A. Goff for the women.

Imposing Program of Authoritative Speakers for A.S.M.E. National-Defense Meeting, Pittsburgh, Pa., May 2, 1941

THE technical phases of national defense is the theme of the Fourth A.S.M.E. National-Defense Meeting to be held at Pittsburgh, Pa., on May 2. An imposing program of authoritative speakers has been arranged.

The meeting will be divided into two concurrent sessions: The first dealing with problems, materials, and industries contributing directly to national defense, and the second session treating industries and materials, which are a necessary part of the national-defense program but which contribute indirectly.

Program for First Session

Ordnance requirements and production will be the subject of a paper to be delivered by Lt. Col. James L. Guion, Chief of the Pittsburgh Ordnance District.

The airplane industry, its production problems, and what is being and can be done to speed production, in this the youngest and most vital arm of our national-defense program, will be covered in a paper to be delivered by a member of the Office of Production Management. The stress under which the Office of Production Management is working does not permit naming the speaker at this early date.

Priorities, a troublesome but necessary problem, will be dealt with in a paper to be presented by a member of the National Priorities Board. In this case also it is not possible to give the name of the speaker at this early date.

"Aluminum and National Defense" will be treated in a paper by Sanford Colby, vice-president, Aluminum Company of America.

"Rubber and National Defense" is the subject of a paper to be delivered by Dr. Webster N. Jones, who is director of engineering, at the Carnegie Institute of Technology.

"Steel and National Defense" will be treated in a paper by T. J. Loughlin, assistant to vice-president, Carnegie Illinois Steel Co.

Serving as chairman of this session is Frank B. Bell, Chief of the Pittsburgh Ordnance District.

Program for Second Session

"Mechanical Features of the Frank R. Phillips Power Station" is the title of a paper to be presented by Walter H. Jones, mechanical engineer, Duquesne Light Co. This is the first paper to be given on this projected newest link in the Duquesne Light Co. generating system.

"Modern Boiler Design" is the subject of a paper to be given by J. C. Hobbs, vice-president and general manager, Diamond Alkali Co.

"Developments in Continuous Annealing of Steel Strip" is the title of a paper to be delivered by J. D. Keller of Associated Engineers, Pittsburgh. This paper will be discussed by J. B. Austin, research engineer, U. S. Steel Corporation.

"Controlled Atmosphere" a paper dealing with heat-treating, the control of oxidation, carburization, the bright annealing of steel, etc., will be given by J. R. Geir, research engineer, Westinghouse Research Laboratory. It will be discussed by M. H. Mawhinney, consulting engineer, Crucible Steel Co.

The chairman of the morning session will be Thomas E. Purcell, general superintendent of Power Stations, Duquesne Light Co.; and of the afternoon session W. Trinks, professor of mechanical engineering, Carnegie Institute of Technology.

Varied Technical Subjects and Problems of Southern Industry Discussed at 1941 A.S.M.E. Spring Meeting Atlanta, Ga., March 31–April 3

SWELLED by a large number of A.S.M.E. Student Members from the 16 colleges comprising the Group IV 1941 Student Conference which met in Atlanta, Ga., as guests of the Georgia School of Technology, attendance at the 1941 Spring Meeting, March 31 to April 3 at the Atlanta Biltmore Hotel reached the six-hundred mark. From as distant points as Pasadena, Milwaukee, Chicago, Toronto, Cambridge, New York, Philadelphia, Washington, Gainesville, Fla., and New Orleans, with a liberal sprinkling of inland cities of the Midwest, A.S.M.E. members assembled to hear an excellent program of 27 papers delivered at 15 technical sessions, to sample the hospitality of the cordial group of Atlanta hosts, and to visit the industrial plants of the vicinity.

Immediately following the program at Atlanta, members interested in the textile industry moved on to Greenville, S. C., to attend the Engineers' Day Dinner on April 3 at the Poinset Hotel, where W. A. Hanley, President A.S.M.E., spoke, and to take in the Southern Textile Exposition on April 4 and 5.

A backward spring disappointed visitors from the North who had promised themselves a foretaste of dogwood in brilliant splendor, which was effectively advertised on the front cover of the March issue of MECHANICAL ENGINEERING and gave occasion for some good-natured ribbing that sent the editor out to make a personal inspection of Ponce de Leon Drive and other portions of the city of beautiful modern residences. Daffodils, flowering shrubs, peach trees in bud, and intensely green lawns bathed in sunlight and the soft warm air that would not reach New England for another month were adequate compensation for the lateness of the dogwood.

Varied Technical Program Included Many of Local Interest

The technical program opened on Monday evening with three sessions sponsored by the Power and Textile Divisions and the Committee on Education and Training for the Industries. The greater portion of the group, including a large number of student members attracted by the opportunity of hearing W. LeR. Emmet, A.S.M.E. Medalist, talk about the mercury-vapor process, attended the power session, at which the opening paper was presented by D. C. Carmichael, industrial engineer, E. I. du Pont de Nemours and Co., Wilmington, Del., on an experimental study of feedwater treatment for boilers operating at 1400 psi.

The Textile Division directed its attention to national-defense subjects. Stephen C. Hale, member A.S.M.E., took time out from his duties as chairman of the Hotels and Program Committee and service on the Atlanta executive committee to tell about the cooperation of the textile industry with the national-defense program, and Allen Jones, general superintendent, Muscogee Mfg. Co., Columbus, Ga., explained the need for personnel training in the textile industry and the steps management has to take in absorbing a training program.

Some truly remarkable and revealing motion pictures of metal cutting, highly magnified and taken at high speed so that they could be run slowly in projection, were exhibited at the session on education and training. The pictures clearly showed the deflection of the tool under pressure, the deformation of the material being cut, the built-up edge ahead of the cutting tool, and, in milling, the instantaneous but complete stopping of the cutter after the cutting edge had emerged from the stock. A. R. Stevenson, Jr., of the Committee on Education and Training for the Industries, explained that the pictures, taken at the Schenectady works of the General Electric Company, had undoubted value in any scheme of training machine-shop apprentices. Keen scouts of the A.S.M.E. Student Branch at the Georgia School of Technology carried the films away with them for showing before their branch meeting.

A second set of educational pictures, combining the animated cartoon and talkie effects, put out by the Film Productions Co., Minneapolis, Minn., and loaned for the occasion by Roy A. Clapp, president of the company, demonstrated various metal-cutting practices.

Three more sessions, one sponsored by the Power Division, another, on steam separation, by the Process Industries Division, and the third by the Committee on Education and Training for the Industries, constituted the program for Tuesday morning.

Arthur Pollak, director of research and development of by-products, presented the paper on separation of liquid from vapor with the use of cyclones, with Lincoln T. Work, director of research and development, Metal and Thermit Corp., New York, N. Y., as co-author.

At the power session P. S. Dickey, member A.S.M.E. and director of research, Bailey Meter Co., Cleveland, Ohio, with H. L. Coplen, of the research department of the same company as co-author, outlined a simple procedure for determining damper flow characteristics and discussed the mechanical features and relative merits of damper types.

Preliminary studies and final installation details of new steam plants of the Southern Division of the Commonwealth and Southern Corporation at Macon and Chickasaw were described by E. C. Gaston, member A.S.M.E., mechanical engineer, Commonwealth and Southern Corporation, Birmingham, Ala.

At the second session sponsored by the Committee on Education and Training for the Industries, attention was divided between the problem of college training for national defense and the inspection of Army matériel. R. A. Seaton, member A.S.M.E., and Director of Defense Training, U. S. Office of Education, Federal Security Agency, Washington, D. C., described plans for training in the college grade and the work of the government and the colleges in this field.

The paper by R. W. Case, Brigadier General, U.S.A., Commanding, Watertown Arsenal, Watertown, Mass., on Army Matériel Inspection, was ably presented by Capt. J. E. Getzen, Ordnance Dept., U. S. Army, Assistant Executive Officer, Birmingham Ordnance District. Following the discussion Lt. R. S. Crowder, Ordnance Department, U. S. Army, head of the Inspection Division of the Birmingham Ordnance District, answered queries and described some of the problems in this field.

A third session sponsored by the Committee on Education and Training for the Industries and the Management Division stimulated considerable discussion and presented two phases of the subject of training apprentices for national defense. S. D. Moxley, member A.S.M.E., assistant to the vice-president and chief engineer, American Cast Iron Pipe Co., Birmingham, Ala., described the very successful program that his company has been conducting for several years, in which the schoolwork is handled by the correspondence schools. Bartley Whiteside, supervisor of training, Wright Aeronautical Corporation, Paterson, N. J., described the short-course training methods adopted by his company under the necessity of developing a larger number of men for precision production in a limited space of time, in which emphasis is laid on preparation for work on a particular machine tool.

The A.S.M.E. Fuels Division held its first session on Wednesday morning and its second on the following day. On Wednesday two papers were presented. A. L. Luke, Jr., combustion engineer, West Virginia Pulp and Paper Company, Luke, Md., described his company's experiences with slag-tapping furnaces; and J. A. Reich, superintendent, power plants and substations, Richmond Division, Virginia Electric and Power Company, Richmond, Va., told of experiences in burning various refuse coals blended with better grades at the Twelfth Street Station of his company. F. H. Spies, efficiency engineer of the Twelfth Street Station, Richmond, Va., of the same company, was co-author of the paper.

At the second fuels session on Thursday morning W. J. Lutz, power-plant engineer, gas department, Public Service Electric and Gas Company, Newark, N. J., described a 100,000-lb per hr four-fuel boiler at the Harrison Gas Works of his company and reported difficulties in burning oil, tar, pulverized coal, and pul-

verized fuel pitch in the same boiler and the successful solution found.

Two sessions of the Hydraulic Division, held on Wednesday and Thursday, featured motion pictures by the TVA, one showing the construction of the Norris Dam and the other erosion prevention and flood control. Both films were presented by J. F. Roberts, member A.S.M.E., principal mechanical engineer, Tennessee Valley Authority, Knoxville, Tenn. At the Wednesday session Mr. Roberts, with George R. Rich, assistant chief design engineer, TVA, Knoxville, Tenn., gave details of 80,000-hp and 66,000-hp Francis-turbine installations of the Norris and Hiwassee projects.

At the Thursday session, George T. Abernathy, hydraulic division, Newport News Shipbuilding and Dry Dock Company, Newport News, Va., presented a paper on power-operated rakes for hydraulic intakes.

On Wednesday and Thursday the active A.S.M.E. Committee on Vegetable Oils of the Process Industries Division held two sessions on the subject of vegetable oils. Charles L. Lockett, sales manager, Bauer Bros. Co., Springfield, Ohio, reviewed the history of developments in the mechanical processing of vegetable oils. John F. Leahy, projects director, Engineering Experiment Station, University of Tennessee, Knoxville, Tenn., outlined 12 years of research in the processing of cottonseed at the University of Tennessee.

At the Thursday session, C. W. Bilbe, engineer, Allis-Chalmers Mfg. Co., Milwaukee, Wis., outlined the continuous solvent extraction process for recovering vegetable oils and described a new type of column-type extractor. Problems in the field of tung-oil extraction were discussed by R. S. McKinney, chemist, Agricultural Research Division, Bureau of Agricultural Chemistry and Engineering, U. S. Department of Agriculture, Gainesville, Fla.

The economics of strip mining with portable belt conveyers was the subject of a paper by William W. Kingman, member A.S.M.E., assistant treasurer and general manager, Edgar Bros. Co., Metuchen, N. J., at a session on Wednesday morning under the auspices of the Materials Handling Division.

Two papers dealing with radiation were presented at a session on Thursday morning sponsored by the Heat Transfer Division, H. C. Hottel, associate professor of fuel engineering, and B. B. Woertz, research associate, department of chemistry, Massachusetts Institute of Technology, described the performance of flat-plate solar-heat collectors, with special reference to experiments and apparatus at M.I.T. Radiation problems associated with absorption and radiation by gases were discussed by James Anderson, University of Pennsylvania, Philadelphia, Pa., with L. M. K. Boelter, member A.S.M.E., professor of mechanical engineering, University of California, Berkeley, Calif., as co-author.

L. F. Gordon Addresses Overflow Luncheon

One of the largest luncheons in A.S.M.E. history overflowed the Empire room of the Atlanta Biltmore Hotel on Tuesday noon. The combined attendance of the students, the members and guests, and the women taxed the resources of the hotel. Lewis F. Gordon, assistant vice-president, Citizens and Southern National Bank, Atlanta, gave a stirring address, sprinkled with amusing stories and clever humor that added pungency to his more serious words to student members. He recalled his early engineering days before the Wages and Hours Act had set artificial restrictions on the length of the working day when he had found his greatest satisfaction and personal benefit in keeping on the job after hours. It was a hardship to young men of the present generation, he said, to have to abide by the leveling limitations that the new conditions set. However, he continued, it was evident that the people of the country were becoming more and more conscious of themselves and mass opinion was growing in its influence. With the present trend of events there was evidence of a socialized, but not socialistic, trend in the national life.

Winners of the student-papers contest were announced by E. W. O'Brien, honorary chairman of the Atlanta Committee, with a lively running fire of comment and good humor. A delightful feature of the prize presentations was the "tin shower" for Prof. R. S. King, beloved head of the department of mechanical engineering at the Georgia Institute of Technology. As the 1941 Student Conference was the tenth of the series inaugurated with the development of the present plan of administering A.S.M.E. student branches, it had seemed appropriate to the student representatives to mark the occasion and to honor Professor King in a typically undergraduate fashion. Representatives from each of the student branches present at the conference came forward one by one to bestow upon the good-natured head of the Georgia department certain articles of tinware of various sizes and degrees of usefulness. With dippers and kettles hanging about his neck and a huge washtub in which to carry away these tokens of affection, Professor King was the object of congratulation for his long service to the student branches. Horseplay at an end, the more lasting token was presented by Mr. O'Brien in the form of a brief case, with which went the instruction that every paper put into it must be passed.

President Hanley Addresses Student Delegates

At the Brittain Dining Hall of the Georgia School of Technology on Tuesday night, a considerable number of older men sat down to dinner with the student delegates and listened to an address by W. A. Hanley, President A.S.M.E., whose subject was "Looking Just Ahead." Before the serving of the dinner members of the Georgia Tech glee club sang a number of selections, including, by request, the famous song about the "rambling wreck from Georgia Tech."

Mr. Hanley urged the undergraduate engineers to keep their minds firmly fixed on the objectives they had held before the present national-defense emergency had developed. What interruption they might experience, he said, was like a detour in this road which eventually would lead them back again on the route toward those objectives that each man had picked out for himself. Like other detours, the ones on which they might find themselves would probably afford interesting and valuable experiences.

Asking the question, Will there be engineering in the future? Mr. Hanley pointed out that no matter what might happen the world would not give up what engineers can do for it. He cited many instances of industries and utilities upon which life in the world today depends and for the maintenance of which engineers are essential. He urged every young man to set for himself the task of occupying one of the better places in the organizations served by engineers. There were still hopes for rewards for the competent, the thrifty, and the inventive person. Many phases of engineering—and he mentioned a considerable list—were rapidly developing and would provide opportunity for young men to develop with them.

As to preparation for the life of an engineer, Mr. Hanley listed ambition, interest, scholarship record, cultural development, public-speaking ability, perspective, common sense, and assumption of civic responsibility as important factors. Young men, he concluded, must train themselves to accept responsibility. He emphasized the fact in closing that each young man should join one or more engineering societies, take a part in its affairs, and support it in whatever way presented itself.

Southern Industrial Progress Noted at Luncheon

On Wednesday noon the luncheon in the Empire room of the Atlanta Biltmore was addressed by E. W. O'Brien who presented representatives from various parts of the South to speak of industrial and engineering developments of their districts. These five-minute addresses constituted one of the finest features of the Spring Meeting. The speakers and their announced subjects were: S. D. Moxley, "A Cold Blast Gives Hot Results;" N. C. Ebaugh, "Seeds, Pulps, and Nuts;" R. Lambert (speaking for John P. Ferris), "Objects of TVA;" Blake Van Leer, "Paper to Burn;" James M. Todd, "Salt, Caustics, and Bad Odors."

Following the brief high lights of Southern industrial progress, Frank H. Neely, member A.S.M.E., executive vice-president and secretary, Rich's Inc., Atlanta, Ga., and Chairman of the Board, Federal Reserve Bank, Sixth District, spoke in summary of the South's industrial position. He quoted figures to show the growth of industry in the South and compared the values added by manufacture with similar figures for the nation as a whole. The Sixth Federal Reserve District, he said, had been the scene of about 15 per cent of all manufacturing in the United States. Under conditions created by the war in Europe, this percentage might decrease. Southern machine shops were getting orders, but the managers were not accustomed to Army and Navy contracts which presented numerous problems, such as rises in wage scales, union clauses, and specifications. He spoke briefly of the financing of defense orders and of the policy of basing credit on the ability to produce, which has been adopted by the Sixth Federal Reserve District.

A. H. Koch Presides at Dinner

Although he claimed to be officiating as a

toastmaster for the first time, A. H. Koch, vice-chairman of the A.S.M.E. Atlanta Section and general chairman of the 1941 Spring Meeting Committee at Atlanta, performed his task with such poise and skill that seasoned banqueteers found it hard to believe he was not an old hand at the job. Before a couple of hundred diners and flanked by a distinguished company at the head table, Mr. Koch was complete master of the situation. His first task was to thank Ernest Hartford, executive assistant secretary A.S.M.E., for his aid to the Atlanta Section in conducting the meeting. This was followed by general introductions, which he accomplished by shuffling the names of his table companions and requiring President Hanley to "cut" the deck to avoid responsibility of choosing an order of presentation. In this matter he was fortunate in introducing first his vice-chairman, F. C. Smith, chairman of the Atlanta Section, and Dr. M. L. Brittain, president of the Georgia Institute of Technology. Members of the A.S.M.E. Council, J. W. Eshelman, of Birmingham, Willis R. Woolrich, of the University of Texas, K. H. Condit, of Princeton University, Clarke Freeman, of Providence, R. I., and C. E. Davies, national A.S.M.E. Secretary, were sandwiched in between the two Atlantans and the honorary chairman, E. W. O'Brien, who was introduced last. Perhaps after all there was something more than chance in the card shuffling.

President Hanley Talks on Obligations of Defense

Voicing the Society's appreciation of the courtesy of the Atlanta Section in planning and carrying out the details of the 1941 Spring Meeting, W. A. Hanley, President A.S.M.E., complimented the hosts for their convincing display of Southern hospitality.

He recalled that he had been present in the House of Commons two years before when Chamberlain had made his famous promise of aid to Poland, and he reviewed briefly the momentous world events that had followed that grave pronouncement. It was the duty of this country, he insisted, to see to it that the mistakes that had been made in Europe were not made here, and that what was done that should have been done there should also be done here.

We could not feel happy or secure in this country, he contended, until the philosophy which was animating Germany had been destroyed. Only time and a change in this philosophy would bring peace, he said. It would be our task to talk with dictators in the language of force.

He then reviewed the mistakes made in France which preceded its downfall—shorter hours of labor, inflation, the war debt, political division and disunity, bankruptcy, and unpreparedness. England's unpreparedness and her inadequate air force at the outbreak of hostilities were examples of mistakes that we in this country must not make.

America, he said, was beginning to arm herself, and in doing so she must observe the rules of common sense. We had a fortunate heritage—a high standard of living—and this we wished to preserve. National defense would be our first and most important task for this year and for several years to come. This involved many problems and obligations on our part. First there was the necessity of maintaining a united front. There was the problem of drafting soldiers to serve for $21 per month and the contrast of workers striking for wages of $12 per day. In the present emergency, he said, everyone was under obligation to do his part or he would be made to do it. America had not been built without sacrifice. Its peace and prosperity would be maintained with sacrifice. It was our duty to uphold the Selective Service Act in the spirit in which it was conceived.

Our second obligation was to pay taxes. For years we had piled up debt. Had this been good stewardship, he asked. It was his opinion that we should pay for the ordinary costs of government as they were incurred. To tax the wealthy beyond present rates was unprofitable and hence taxation must bear more heavily on the middle and lower classes. In his opinion, when a government spent money it should have the courage to collect it. The United States must watch its spending and avoid expenditures not in the cause of national defense.

Our third care was not to change our form of government. In this connection we would want to borrow little from modern Europe.

The national emergency, he said, afforded a job for engineers whose responsibilities were great. Engineers could help in every way—they could help industry from within and from without as well. It was their duty to be on the watch for instances of sabotage and to report them. Engineers could serve in their customary position in housing developments, in utility services, in transportation, in education, and in the more recent need for providing air-raid shelters. Shorter vacations and overtime work were the order of the day for engineers, and the operation of schools in summer vacation periods would be required of those in educational fields. Should Germany ever invade England, the need for overtime work would be greatly increased. There must be an end to strikes.

In closing, Mr. Hanley said that it was possible for the United States to build the greatest defensive system the world had even seen. The engineers of the nation were already busy at this task, and they would not be late or found wanting in devotion.

Dean Kimball Looks Ahead

Under the handicap of a severe throat affliction, Dexter S. Kimball, past-president and honorary member A.S.M.E., and serving on the Priorities Board of the Office of Production Management, Washington, D. C., spoke with sanity and sincerity on the subject of defense priorities and the results of the war in Europe.

It has been a shock to discover, he said, that America had been placed in the position of having to defend itself. But the world had become very small, as had been demonstrated in the first world war when a German submarine had shelled Cape Cod, and as was being made even more clear today with the raids now possible by bombers riding the air. To finance the tremendous task of defending this country we had already appropriated 40 billion dollars, seven billion of which would be available to aid other democracies. The question he put to the audience was: How is this money being spent and what will it mean in the future?

The Army and the Navy had certain peacetime duties and production functions which provided the schedule of requirements for defense and developed facilities and equipment that would be needed by them in case of emergency. Its production facilities were inadequate for an emergency and hence industry had been called upon to provide the manufacturing capacity that was needed. In order to plan for defense needs there existed the Army and Navy Munitions Board which knew what should be done and which had laid out a program for its accomplishment. This Board, and this Board alone, could tell us what to do and could name the order of events.

To organize the enormous production facilities needed to carry out the program, the Office of Production Management had been set up by the President. Mr. Knudsen headed this board, Dean Kimball said, and under him were four groups: Purchasing, with Donald M. Nelson in charge; Production, of which John D. Biggers was the head; Priorities, under the direction of Edward R. Stettinius, Jr., with five committees, commercial airplane, chemicals, materials and metals, machine tools, and general. His own responsibility was chairmanship of the priority committee on machine tools.

Dean Kimball then proceeded to give examples of how priorities were set up and rated. The system was one necessary in wartime and we would find it harder than it had been in the previous war.

As to the results of national-defense activities, Dean Kimball said that already a boom was starting. He recalled the "silk shirt" era of the first world war and the depression that followed with the signing of the peace treaty. How soon, he asked, would similar results be seen in connection with the present emergency?

He reviewed the tremendous undertakings and the time and money involved in preparing for national defense, using as examples the building of a navy and of production capacity for airplanes, tanks, and guns. He dwelt on the problem of tooling and precision measurements, recalling that whereas in the first World War we were dependent on Europe for high-precision gage blocks, we were now equipped to produce them in this country.

By the end of the coming summer, Dean Kimball estimated, the nation would be in the midst of a tremendous production effort unless strikes were to prevent it. How would the people take it? he asked. In his opinion they would, on the whole, take it very well if they retained a sense of humor. This effort, he said, would cost tremendous sums of money, and the production would not be for food, clothing, and shelter, but for war materials. For that reason we shall all be poorer and must pay the price in taxes.

In casting his mind forward to the more distant future, Dean Kimball likened our action in entering upon the national-defense program to the unbottling of the genii by the Thief of Bagdad—only we could not entice the genii back into the bottle. The course we had undertaken, he said, was a one-way street.

We shall be "armed to the teeth," with the greatest Army, Navy, and production capacity the world had ever seen. What would be the result?

He recalled how as a young man he worked on the iron cruiser *Charleston* belonging to the new Navy; the beginnings of the Japanese navy; Cuba and the Philippines. Was our role to be that of defender of our own nation, or that of a crusader for the rights of other nations, or that of the oppressor of other nations, he asked. Of one thing he was certain; we would never succeed in putting the genii back into the bottle. We were taking upon ourselves serious responsibilities and obligations that would have to be faced with courage and high moral purpose. To this end he reminded his audience of Kipling's concern for the destiny and obligations of the British Empire; and he closed his address by reciting the first and last stanzas of "Recessional:"

God of our fathers, known of old,
Lord of our far-flung battle-line,
Beneath whose awful Hand we hold
Dominion over palm and pine—
Lord God of Hosts, be with us yet,
Lest we forget—lest we forget!

For heathen heart that puts her trust
In reeking tube and iron shard,
All valiant dust that builds on dust,
And guarding, calls not Thee to guard,
For frantic boast and foolish word—
Thy Mercy on Thy People, Lord!
Amen.

Afternoons of Plant Visits and Golf

With technical sessions scheduled for the morning hours, afternoons at Atlanta were left free for plant visits and recreation. Plant trips were arranged in cooperation with the Student Committee at the Georgia School of Technology and were available for the students and older men alike. Plants visited included the Atlanta Brewery and Central Plant of the Atlantic Company, the General Shoe Company, Bauer Pottery, the Atlanta Incinerator, the Atlantic Steel Company, the Atkinson plant of the Georgia Power Company, the Coca-Cola Bottling Company, and the LeTourneau Company, at Toccoa, Ga., en route to Greenville, S. C. A golf tournament was held Wednesday afternoon at the East Lake Golf Club, laid out by Bobby Jones.

Women Enjoy Atlanta Hospitality

The women in attendance at the Atlanta meeting were treated to a special program of entertainment, sight seeing, and shopping tours at times while technical sessions were being held and joined the men at luncheons and dinner. On Tuesday morning there was a sight-seeing bus tour of Atlanta and vicinity with visits to Stone Mountain and Atlanta's famous Cyclorama. In the afternoon a tea and style show was enjoyed at Rich's, Inc., one of Atlanta's leading department stores, followed by an informal "get-together" party with the men in the Pompeian Room at the Atlanta Biltmore, where music and entertainment were provided by Graham Jackson and members of his company.

A "Gone With the Wind" tour on Wednesday morning afforded the visitors an opportunity to visit the historic spots that served as a background for the famous novel and motion picture. The afternoon was devoted to a bridge luncheon at the Atlanta Biltmore.

Success of Meeting Credited to Work of Committees

All A.S.M.E. national meetings are under the general supervision of the Committee on Meetings and Program, with the technical program arranged by the professional divisions and Society committees. But when the Society holds meetings outside New York a tremendous amount of detail is carried on by local committees, and it is upon their efforts that success largely depends.

Arrangements at Atlanta were under the direction of A. H. Koch, general chairman; F. C. Smith, vice-chairman; R. L. Sweigert, vice-chairman; and E. W. O'Brien, honorary chairman, with an executive committee consisting of E. W. O'Brien, S. C. Hale, and R. S. King.

An honorary committee made up of representatives of A.S.M.E. sections in the Southeast was constituted as follows: Atlanta, E. W. O'Brien, J. M. Sikes; Birmingham, H. S. Kent, S. D. Moxley; Cincinnati, E. S. Sauerbrunn; East Tennessee, T. C. Ervin, R. W. Morton; Florida, J. H. Clouse, N. C. Ebaugh; Greenville, R. H. Hughes, A. D. Asbury; Louisville, Melvin Sack, Ford Wilkinson; Memphis, M. D. Rust, C. M. McCord; New Orleans, L. J. Lassalle, J. M. Todd; North Texas, R. M. Matson, H. R. Pearson; Piedmont, R. P. Reece, E. E. Williams; Raleigh, C. E. Kerchner, B. R. Van Leer; Savannah, W. L. Mingledorff, Jr., A. M. Ormond; South Texas, C. W. Crawford, H. G. Hiebeler; Virginia, G. C. Molleson, J. B. Jones; and Washington, D. C., G. F. Jenks and C. E. Miller.

The subcommittees were as follows:

Finance and Ticket Sales: T. E. Bell, chairman; W. B. Cooper, W. C. Erwin, E. W. Lawrence, W. J. McAlpin, R. S. Newcomb, J. M. Rittelmeyer, T. E. Smith, L. A. Stapleton, and J. M. Trappnell.

Hotel and Program: S. C. Hale, chairman; Earle Mauldin, E. G. Field, A. C. Keiser, Jr., W. C. Kirby, and F. H. Neely.

Publicity and Printing: M. F. Merl, chairman; E. R. Beede, G. M. Mankin, M. J. McWhorter, G. A. Robertson, and E. L. Shuff.

Reception: C. L. Huey, chairman; E. V. Camp, W. V. Dunkin, W. P. Durst, N. E. Elsas, O. C. Falkovich, J. B. Glover, R. B. Hall, A. D. Holland, E. W. Klein, Sr., R. G. LeTourneau, S. V. Moshkoff, L. W. Robert, Jr., Edward Stauverman, Jr., P. H. Thomas, and R. A. Trotter.

Registration: W. G. Coyle, Jr., chairman; W. O. Alt, E. E. Ford, H. R. Hudson, S. T. Memory, Jr., A. F. Poor, Jr., R. C. Robertson, H. S. Weber, and J. M. Windham, Jr.

Plant Trips: George Braungart, Jr., chairman; H. K. Aldinger, R. N. Benjamin, C. L. Emerson, H. W. Mason, and P. R. Yopp.

Sports: J. A. Dodd, chairman; J. M. Kahn and R. A. Martin.

Ladies' Events: Mr. and Mrs. S. M. Snyder, Jr., chairmen; Mr. and Mrs. J. W. Parker, Jr., Mrs. T. E. Bell, Mrs. J. A. Dodd, Mrs. S. C. Hale, Mrs. C. L. Huey, Mrs. A. H. Koch, Mrs. M. F. Merl, Mrs. E. W. O'Brien, and Mrs. J. M. Rittelmeyer.

Instruments and Apparatus, Part 2, Pressure Measurement—Chapter 5 on Liquid-Column Gages

Preliminary Draft of Information on Instruments and Apparatus Section on Liquid-Column Gages Completed

THE draft of Part 2, Chapter 5 on Liquid Column Gages, is completed and the A.S.M.E. Power Test Codes Committee on Instruments and Apparatus welcomes criticism or comment on it by members of the Society and others interested. Copies may be obtained by addressing the Committee at A.S.M.E. headquarters.

The Committee in charge of developing this part of the Power Test Codes activity consists of W. A. Carter, chairman, C. M. Allen, W. C. Andrae, E. G. Bailey, H. S. Bean, L. J. Briggs, J. D. Davis, K. J. DeJuhasz, R. E. Dillon, F. M. Farmer, J. B. Grumbein, W. W. Johnson, W. H. Kenerson, E. S. Lee, E. L. Lindseth, O. Monnett, S. A. Moss, R. J. S. Pigott, E. B. Ricketts, W. A. Sloan, R. B. Smith, and I. M. Stein.

The importance and frequent use of liquid column gages in measuring pressures below and slightly above atmospheric pressure as well as differential pressures in the testing of power-plant equipment prompted the Committee on Instruments and Apparatus to devote a chapter to the various types of indicating gages used for this purpose.

This chapter includes sections dealing with vertical U-tubes, single-leg tubes, inclined U-tubes, liquid draft gages, absolute-pressure gages, installation, precautions in use, and calibration.

Liquid-column gages measure pressures referred to atmospheric or differential pressures by the height of a column of liquid balancing the two pressures involved. The length of the column can be varied by the use of different liquids or by inclining the instrument. The cross-sectional area of the column has to be adequate to minimize the effect of capillarity at the meniscus.

Cleanliness of the gage tubes and the liquid are important factors in obtaining reliable measurements. The scales and sliders used in measuring the height of the liquid column may be inadequate in some cases, and recourse need be made to the use of hook gages and micrometer reading devices in order to accomplish the desired accuracy.

Temperature of the gage cannot be neglected, as the density and therefore the height of the column observed varies noticeably with temperature.

Among the Local Sections

Copy must be at headquarters on the sixth of each month to be included in coming issue

Akron-Canton, Baltimore, Milwaukee, and Minnesota Sections Welcome President of A.S.M.E., William A. Hanley

Hundreds of Members and Guests Hear Paper on Subject of "Why National Defense—An Engineer's Viewpoint"

ENTHUSIASTIC audiences consisting of members and guests of the Akron-Canton, Baltimore, Milwaukee, and Minnesota Sections attended meetings at which William A. Hanley, President of The American Society of Mechanical Engineers, discussed "Why National Defense—An Engineer's Viewpoint." In his paper, President Hanley reviewed the events leading up to the present European War, cited our needs in order to prepare the National Defense of the country quickly, advocated higher taxes to pay for the program and a reduction in the budgets of the W.P.A., N.Y.A., and A.A.A., and recommended that the 1942 class of engineering colleges should be graduated in January instead of June.

Akron Visited on Feb. 27

Akron-Canton Section was host to President Hanley on Feb. 27 in Akron, Ohio. Following a luncheon with the executive committee of the Section at the Mayflower Hotel, he addressed a meeting of the A.S.M.E. Student Branch at the University of Akron. This was followed by a visit to the bedside of Edwin C. Shaw, 50-Year Member of the Society and prominent local engineer. In the evening, more than 200 members and guests of the Section attended a dinner meeting given in honor of President Hanley and heard him give his interesting paper.

Baltimore Welcomes Him on March 20

Approximately 175 members and guests of Baltimore Section came to the March 20 meeting to welcome President Hanley and hear his talk. Many student members of the A.S.M.E. Student Branch of Johns Hopkins University, who had heard the guest of honor in the afternoon at a meeting held at the school, also attended the evening session. Other guests included C. E. Davies, secretary, Alexander G. Christie, past-president, and H. H. Snelling, past vice-president of the Society.

Milwaukee Visited on March 5

Fifty-five members and five guests of Milwaukee Section were on hand on March 5 to honor President Hanley and hear his interesting talk. Everyone had an opportunity to meet the guest of honor and greet him.

Minnesota Section Hears Him March 3

Meeting in Minneapolis on March 3, more than 100 members and guests of the Minnesota Section welcomed President Hanley, whose talk was of unusual interest due to the speaker's recent experiences and observations in Europe and America. Another speaker was A. Gordon Gutteridge, a consulting civil engineer sent to America by the Australian government, who outlined his country's efforts in becoming a self-sustaining nation as well as providing military supplies for both its overseas and its home defense forces.

Plastics Discussed Before 50 of Anthracite - Lehigh Valley Section

PLASTICS was the topic of the March 28 meeting in Scranton of the Anthracite-Lehigh Valley Section. S. Leon Kaye, the speaker of the evening, covered the history of the product from its first appearance in 1869 until the present time. The talk was followed by a sound color film, "Magic of Modern Plastics," which was enjoyed by the fifty persons who were present.

Bridgeport Engineers Learn Ways of Solving Personnel Problems

More than 120 members and guests of Bridgeport Section of the A.S.M.E. and the Engineers Club of Bridgeport attended the March 6 joint meeting at which Harold B. Bergen, chairman of the Management Division, A.S.M.E., was scheduled to speak on "Solving Personnel Problems." However, since Mr. Bergen was unable to come, his place was ably filled by John Smith, McKinsey & Co. Some of the topics covered included the employment of workers, simplification of operations, wages, safety, social security, and labor relations.

Buffalo Section Sponsors A.S.M.E. Student Group at Local University

As part of its work in student engineering education, the Buffalo Section has organized an A.S.M.E. Student Group at the University of Buffalo. About 20 of the students in conjunction with 130 members and guests of the Section attended the March 12 meeting. P. E. Biggar, executive engineer of General Motors Corp., spoke on "Diesel Engines," illustrating his talk with slides and sound motion pictures.

William B. Stout Talks to 200 Dayton Engineers

William B. Stout, famous automotive and aeronautical engineer, was the guest speaker before 200 members and guests of Dayton Section on April 3. Taking as his subject, "Aviation and Future World Progress," Mr. Stout said that the future of aviation lies in the

PRESIDENT HANLEY ADDRESSED A.S.M.E. STUDENT BRANCH AT AKRON UNIVERSITY DURING HIS VISIT TO THE AKRON-CANTON SECTION ON FEB. 27

(Although there are forty members in the Branch, not all were able to be present when the photograph was taken. From left to right in the first row are Leander Haddock, chairman of the Branch, E. D. George, secretary-treasurer of the Akron-Canton Section, Prof. F. S. Griffin, honorary chairman of the Branch, President William A. Hanley, Robert McCurdy, vice-chairman of the Branch, Dante Bell, and Frank Vukan.)

small "puddle-jumper" or privately owned airplane and predicted that in three years a small foolproof airplane of 100 hp and a cruising speed of 170 mph would sell for less than $1000 and that in ten years private airplanes will be as common as automobiles today. In conclusion, he stated, "The great amount of private plane expansion in the future will mark the second coming of age of aviation."

Houdry Process Shown and Described to Detroit Members

On the afternoon of March 4, 50 members of Detroit Section inspected the Socony Vacuum-White Star Oil Company refinery at Trenton, Mich., and viewed modern automatic equipment for high-yield production of automotive fuel. Also seen were a gas turbine driving a centrifugal air compressor and an a-c induction generator. Following a dinner at the Dearborn Inn, C. R. Miller, consulting engineer of the company, described the Houdry catalytic gasoline process, which made it possible to increase the yield of motor fuel from crude oil from 20 to 70 per cent.

About 100 members and guests heard C. J. Phillips, Corning Glass Works, address the April 1 meeting of the Section on the topic of "Glass in Industry." Production methods are so far advanced today that one machine can turn out 700 electric-light bulbs in one minute. Other modern developments include glass tempered by immersion in cooling salts at 250 C in order to produce high-strength industrial glass.

Greenville Section Meets With Clemson Branch Members

St. Patrick's Day, March 17, was the occasion for a joint meeting between Greenville Section and Clemson Student Branch. E. B. Brown, student member, gave a paper on pneumatic riveting in aircraft construction; S. N. Snyder, junior A.S.M.E., spoke on fusion welding; and A. D. Asbury and Dean S. B. Earle discussed William L. Batt's paper published in the January issue of MECHANICAL ENGINEERING.

Central Illinois Section Sponsors Symposium on Utilization of Midwestern Coals

A two-day symposium on the preparation and utilization of Midwestern coals was held by the Central Illinois Section in Peoria, Ill., March 14–15. Papers were presented at the Friday afternoon and Saturday morning sessions by A. B. Openshaw on "Burning Midwestern Coal on Traveling or Chain-Grate Stokers," E. A. Beckwith on "Burning Midwestern Coal on Spreader-Type Stokers," A. C. Foster on "Some Problems Encountered in Pulverizing and Burning Low-Grade Illinois Coals," U. C. Major on "Burning Illinois Coal on Water-Cooled Underfeed Stokers," and Ollison Craig on "Design of Furnace for Firing Pulverized Midwestern Coal." At the Friday dinner, Otto DeLorenzi showed natural-color movies on the operation of furnaces on underfeed, chain-grate, and pulverized-fuel firing. Saturday afternoon, inspection trips were made to the Central Illinois-East Peoria Power Plant and to the Hiram Walker & Sons distillery.

Members of Central Indiana Hear Talk on Management

The annual joint meeting of the Purdue Student Branch and the Central Indiana Section was held on March 14. Walter Stephenson discussed "The Job Which Faces Manufacturing Management in a Defense Economy Program." Prof. C. W. Beese presided over the spirited discussion which followed Mr. Stephenson's talk.

Spectroscopy Is Topic of Ithaca Section Meeting

Applications of spectroscopy in industry were described by K. J. McKenzie at the March 20 meeting of the Ithaca Section. Shown to the 60 who attended the session were slides of apparatus, methods, and spectrograms.

NLRB and Walt Disney Studio Features of Los Angeles March Sessions

On Thursday evening, March 13, the Los Angeles Section held a dinner meeting attended by 130 members who learned about the activities of the NLRB from William Walsh, attorney for the board in the Los Angeles area. In addition to Mr. Walsh's talk, an exhibit of gas-engined model airplanes was shown and described by J. B. Bunch.

On March 20, 132 members of the Section were guests of the Walt Disney Studio at a dinner meeting, which was arranged by J. L. Ledeen, mechanical engineer. After an excellent dinner, the making of animated cartoons was explained by Mr. Ledeen, and a preview of "Bambi," the next Disney full-length feature motion picture, was shown. Mr. Ledeen then described the many problems met and solved in the construction of the new studio, especially those pertaining to the air-conditioning requirements of the animator's coloring and film-processing sections.

Minnesota Section Holds Two Joint Meetings During March

A joint meeting of the Minnesota Section, of the A.S.M.E. and A.I.E.E. was held on March 27 in Minneapolis. Dr. Royal W. Sorenson, president of the A.I.E.E., gave a talk on "Engineering Horizons Limited," in which he reviewed the field of engineering in general and made particular reference to the projects which are being undertaken at the California Institute of Technology at the present time.

On March 31 the Section sponsored a joint meeting with the Engineers Society of St. Paul at the University of Minnesota Farm Campus. Dr. Clyde Bailey and Prof. William Boss gave brief talks. This was followed by a conducted tour through the laboratories and shops of the department of agricultural engineering.

Repair of Locomotives by Welding at New Haven

At a joint meeting of the New Haven Section of the A.S.M.E. and the Connecticut Section of A.W.S. held on March 18 at Yale University, James Partington, member A.S.M.E. outlined the application of welding practice to the fabrication and repair of modern locomotives of various types and illustrated his talk before the 80 engineers with lantern slides showing modern types of locomotives and welding assemblies of construction.

Norwich Section Holds Two Interesting March Sessions

The National Defense training program was pictured to the members of Norwich Section on March 5 in a talk given by Dean John H. Lampe. Of particular interest to all was the part being played by Connecticut engineers in the project.

Powder metallurgy was the subject of the March 26 meeting. Richard P. Seelig outlined the history of the process, discussed the theory and principles, and elaborated on points of interest to mechanical engineers, such as the variety of shapes which are available, economical advantages, properties, and limitations.

275 Philadelphia Engineers Hear Paper on Industrial Training

Frederick E. Searle, superintendent of Ford Schools, before a group of 275 members and guests of Philadelphia Section outlined the details of operation of the Ford Trade Schools in Dearborn and impressed the audience with the excellent work in the instruction given to the youth attending the schools. The work produced in the schools is so accurate that it is used in the Ford plants. Participating in the discussion that followed were Prof. William C. Ash, William E. Brunton, and Dr. A. M. Jones.

Student Member Session Held by Providence Section

For the first time in five years, Providence Section acted as host to student members from the A.S.M.E. Student Branches of Brown University and Rhode Island State College in order to acquaint the students with the members of the Section. After a dinner, the youngsters were welcomed by Clarke Freeman and A. C. Chick. This was followed by the showing of colored films, both still and movie, of a trip made through the West and Mexico by Prof. William H. Kenerson of Brown University.

Statistics on Power Development Before Raleigh Members

Fifty-five members and guests of Raleigh Section met on March 11 to hear Davis S. Nabow, who traced the development in electric-generating capacity of the Duke Power Co. from 1910 to 1940. The kwhr output in 1910 was 600 million as compared to the 1940 figure of three billion. Another interesting figure was the one showing that the Duke Power Company produced two per cent of the national output, 53 per cent from hydroelectric plants, and 57 per cent from steam plants.

San Francisco Transportation Meeting Held on March 27

The March 27 meeting of San Francisco Section featured papers by W. E. Martin on "Modern Developments in Electric Marine Propulsion," and William Moody on "Application of Steam to Modern Transportation Requirements." Mr. Martin discussed the recent adoption of electric couplings on vessels which make possible the elimination of all thrust and permit immediate and positive control during maneuvering. The Besler type of boiler and its application in railroad transportation were covered by Mr. Moody.

Following the luncheon on March 6, Robert D. Spear, Foster-Wheeler Corp., addressed the Section on the subject, "Modern Marine Boilers." He showed how this type of boiler is abreast of those which are installed in stationary plants in efficiency and design.

Dean Sackett Talks Before East Tennessee Section

Dean Robert L. Sackett was the guest speaker at the March 6 meeting of the East Tennessee Section held in Knoxville. An audience of 11 members, 9 student members from the University of Tennessee, and 17 guests of the Section were present to hear him give a paper dealing with the "New Forces That Mold Engineering."

Aviation in National Defense at Washington, D. C., Section

At the March 28 meeting of the Washington, D. C., Section, members heard Colonel G. de Freest Larner, general manager and secretary of the National Aeronautic Association, discuss "Practical Application of Aviation to the Present Emergency."

Junior Group Activities

Copy must be at headquarters on the sixth of each month to be included in coming issue

Los Angeles Juniors Visit Aircraft Die-Casting Plant

ON March 5 and 6, Los Angeles Juniors in groups of 26 visited the new plant of the Harvill Aircraft Die Casting Co. The manufacture of aluminum-alloy, magnesium, lead, zinc, and bronze die castings of all types was shown, along with inspection methods, machining practice, metallographic inspection and testing, and metal recovery and purification.

U.S. Garand Rifle Described to Washington Juniors

APPROXIMATELY 40 members and guests of the Washington, D. C., Junior Group attended the dinner meeting held on March 20. Howard R. Booth introduced W. J. Landen, the speaker of the evening, who is chief of the rifle section of the small-arms division, Ordnance Department, U. S. Army. Mr. Landen detailed the many steps which led to the development of the Garand rifle and then exhibited one of them to the audience, explaining the function of each of the 74 component parts. The meeting was concluded with a very interesting discussion.

A.S.M.E. Juniors of Milwaukee Have Paper on Turbogenerators

TWENTY-FIVE Milwaukee Juniors gathered on Feb. 27 in the Hotel Pfister for the monthly meeting. W. F. King, Allis-Chalmers Co., covered the theoretical and practical considerations of balancing and critical speeds in relation to turbogenerators. The discussion that followed proved so interesting that almost everyone present took part in it.

A.S.M.E. Local Sections

Coming Meetings

Akron-Canton. May 15. M. O'Neil's Tea Room, Akron, Ohio, at 6:45 p.m. Subject: "High-Pressure High-Temperature Research at Purdue University," by G. A. Hawkins, professor of mechanical engineering, Purdue University, Lafayette, Ind. This lecture will be illustrated with slides. The Student Branch at the University of Akron will be the guests at this meeting.

Anthracite-Lehigh Valley. May 23. Moose Hall, Hamburg, Pa., at 8:00 p.m. Subject: "Powder Metallurgy," by Harvey N. Davis, past-president A.S.M.E., and president of Stevens Institute of Tech., Hoboken, N. J.

Bridgeport. May 23. Stamford Gas & Electric Auditorium, Stamford, Conn., at 8:00 p.m. There will be a speaker with films, etc., from the Underwriters Laboratories, Inc., of Chicago, Ill.

Central Illinois. May 8. Peoria, Ill., at 6:30 p.m. President William A. Hanley will address the Section membership on the subject: "Why National Defense—An Engineeer's Viewpoint."

Chicago. May 9. Imperial Room, Chicago Towers at 6:30 p.m. This is the Section's Annual Meeting and election of officers, with a reception to President William A. Hanley. Subject: "Why National Defense—An Engineer's Viewpoint," by President William A. Hanley.

Cleveland. May 15. Cleveland Engineering Society at 8:30 p.m. This will be a special meeting, devoted to railroads.

Erie. May 19. Knox Hall, Church of the Covenant, at 6:30 p.m. James H. Herron, past-president of the Society, will speak. Miss Allison C. Bearce of the Boston Museum Art School will speak on "Leonardo the Engineer."

Detroit. May 6. Private Dining Room, L'Aiglon, Fisher Building, dinner at 6:30 p.m. Meeting at 7:45 p.m. Subject: "High-Temperature Steam Generation," by Martin Frisch, chief engineer, Foster-Wheeler Corporation.

May 9. Inspection of Weadock Power Station. For information on arrangements, communicate with A. M. Selvey, 22738 Nona Ave., Dearborn, Mich.

Los Angeles. May 20. Joint Meeting of Founder Societies in evening at Elks Club. Subject: "Science and the Rational Animal," by Dr. Max Mason, chairman of the Observatory Council, California Institute of Technology; formerly president of Rockefeller Foundation and Chicago University.

New Orleans. May 12. St. Charles Hotel, New Orleans, La., dinner at 6:00 p.m. Meeting at 8:00 p.m. Subjects: "Why National Defense—An Engineer's Viewpoint," by William A. Hanley, President of the A.S.M.E.; "The Need for Further Development in Gas Cycling and Condensate Recovery," by L. Reid, University of Oklahoma. (Joint meeting with the Louisiana Engineering Society.)

Ontario. May 9. Dinner Meeting at the Iroquois Hotel, Galt, Ont., Canada. This will be a joint meeting with the Grand Valley Engineers, Brantford, Ontario, and a special invitation will be extended to the engineers of Babcock Wilcox & Goldie-McCulloch, Ltd., Galt, Ontario. An inspection trip is planned to the Galt Aircraft School. Subject: "Engineering Design Technique Applied to Social and Economic Problems," by M. J. C. Lazier, manager, Massey Harris Co., Ltd., Aircraft Division, Weston, Ont.

Philadelphia. May 27. Overbrook Country Club, Philadelphia, Pa. Election of new officers, etc., with a golf game in the afternoon.

Pittsburgh. May 2. See page 401 for details.

Washington, D. C. May 8. Annual Dinner of the Section, election of officers, presentation of student awards. William L. Batt, past-president A.S.M.E., will be the speaker.

With the Student Branches

Hundreds of A.S.M.E. Student Members Turn Out to Welcome National President

William A. Hanley Visits Student Branches, Including Akron, Brooklyn Poly, Johns Hopkins, Lafayette, Lehigh, Purdue, and Wisconsin

WILLIAM A. HANLEY, President of the A.S.M.E., is being welcomed at each engineering college he visits as the champion of engineering students since he was the first to bring to the attention of government officials the importance of young engineers in the National Defense Program. Student members of the A.S.M.E. at Akron, Brooklyn Poly, Johns Hopkins, Lafayette, Lehigh, Purdue, Wisconsin, and other schools regarded themselves fortunate in meeting and hearing this prominent engineer who is devoting so much of his valuable time to their interests.

100 Addressed at Akron

President Hanley talked to 100 members and guests of AKRON BRANCH on the afternoon of March 27, taking as his subject, "Engineering as a Vocation." He captured the interest of everyone at the meeting with his thought-provoking address in which he urged engineering students to study hard because, according to him, ". . . . it is far more important to be known as a good bridge designer than a good bridge player." As far as the future of engineering is concerned, he said, there will always be a demand for good engineers.

More than 50 of the student members were so desirous of hearing Mr. Hanley speak again that they attended the evening session of the Akron-Canton Section of the Society at which he propounded the question, "Why National Defense—An Engineer's Viewpoint." The boys from the University of Akron were particularly enthusiastic about Mr. Hanley's suggestion that the graduation of the 1942 class of engineers be advanced from June to January.

Johns Hopkins Welcomes Him

On March 20, Prof. A. G. Christie, past-president A.S.M.E., introduced President Hanley to more than 100 members and guests of JOHNS HOPKINS BRANCH. His talk on "The Future of Engineering" was greatly appreciated by the audience as shown by the applause which continued long after its conclusion. At the same meeting, cash prizes for the best papers presented during the term were given to P. G. Olson, Marvin Whitmore, and T. W. Smith.

He Talks at Lafayette

Student members of LAFAYETTE BRANCH gave President Hanley a real old St. Patrick's Day welcome on March 17. In return he gave them advice about their future and told them how to go about making a success in engineering. The A.S.M.E. official pointed out that there was even a demand for engineers in Soviet Russia which is chiefly an agricultural country, and that there was a need for 150,000 engineers in the United States today. In conclusion, he suggested that graduates bring their problems to the faculty.

Hanley Visits Alma Mater

Five hundred members and guests of PURDUE BRANCH gathered on Feb. 11 to welcome President Hanley, class of 1911, who presented the engineer's viewpoint of "National Defense." He outlined the steps necessary to ". . . protect the most precious piece of ground in the world as well as the liberties fought for and won by our ancestors." Speaking from actual experience in Europe obtained during the period immediately preceding the downfall of Norway, Denmark, Belgium, Holland, and France, Mr. Hanley emphasized that we must profit by the mistakes made by these countries and by England, which, he said, were woefully unprepared.

Lehigh Honors A.S.M.E. President

Upon his arrival at Lehigh University on March 17, the officers of the Pi Tau Sigma chapter conferred on him honorary membership. Following dinner with 25 members and guests of the LEHIGH BRANCH, President Hanley was taken to the Packard Laboratory where he addressed 150 engineering students on the engineer's part in national preparedness. The talk was well received and proved very stimulating to everyone who was present.

Large Turnout at Brooklyn Poly

More than 100 members and guests were present at the session of March 19 when John A. Lawrence, chairman of the BROOKLYN POLY BRANCH, introduced to the gathering President Hanley who spoke on "Engineering for the Future." He pointed out that no matter what the outcome of the present situation, there will always be a great demand for trained engineers in all nations. In conclusion, he stated that the big challenge confronting engineers and scientists is the need for newer and cheaper forms of energy.

Wisconsin Members Enjoy Him

Chairman Roger Wright of WISCONSIN BRANCH introduced President Hanley to the 50 members and guests who were present for the March 4 meeting. Taking as his subject, "The Future of Engineering," he emphasized the fact that any young man who is sincerely interested in the engineering profession can make a good living as an engineer. The large gathering around the guest of honor at the end of his talk showed the interest of the members in the topic and the appreciation for his coming.

A.S.M.E. Southwest Student Branches, Group VII, Hold First of 1941 Conferences

THE first of the 1941 A.S.M.E. Group Student Meetings was held by the Southwest Student Branches, Group VII, on March 27 and 28 at Houston, Texas, with Rice Institute Branch as host. An attendance of 197 student members, faculty, and guests was drawn from the University of Oklahoma, A.&M. College of Oklahoma, University of Arkansas, Southern Methodist University, A.&M. College of Texas, Texas Technological College, University of Texas, Rice Institute, and the City of Houston.

On the first day of the meeting, Thursday, March 27, an inspection trip was made to the plant of the Hughes Tool Company. This was followed by luncheon served in the plant through the courtesy of the company. At the technical session held that afternoon H. S. Jenkins, chairman of the Student Branch of the University of Arkansas, presided and eight students presented papers.

The Banquet

The banquet, always the high spot of any meeting, was held that evening at the River Oakes Country Club with 177 persons in attendance. V. B. Meyer, convention chairman, served as toastmaster, and C. L. Orr, vice-president of the A.S.M.E. South Texas Local Section, Professor Linn Helander representing President Hanley, and C. L. Kessler of the Ford Motor Company, addressed the gathering. Mr. Kessler who was a member of one of Admiral Byrd's Expeditions spoke on "Experiences With Admiral Byrd at the South Pole." Dancing and entertainment concluded a gala occasion. Souvenirs donated by ten firms were distributed during the banquet festivities.

Early on Friday morning, March 28—at 7:30 a.m., to be exact, the honorary chairmen of the Branches of the Group met at breakfast, with A. H. Burr, honorary chairman of the Rice Institute Branch presiding. It was decided that the 1942 meeting of Group VII be held at the University of Oklahoma.

At the conference the A.S.M.E. Standing Committee on Relations With Colleges was represented by Prof. Howard E. Degler.

Prizes Awarded

The second technical session of the meeting followed, which was presided over by James Close, of the University of Oklahoma. Eight

more technical papers were presented. Prizes for the best of the sixteen papers which had been presented during the conference were awarded after the luncheon on Friday at which James Duffy, chairman of the Rice Institute Branch, presided.

Professor Helander presented the prizes as follows:

$35 to Ernest Graves of the University of Oklahoma
$25 to B. H. Amstead of the University of Texas
$15 to M. C. Sullender of Rice Institute
$10 to William Ford of the University of Oklahoma
$10 (Old Guard Prize) to J. W. Mann of Southern Methodist University
Slide rule to W. E. Bauman of Texas Tech
"Handbook of Engineering Fundamentals" to A. S. Payne of the University of Texas
Slide rule to F. M. McCullar, of Texas A.& M.
Purolator Oil Filter (luncheon door prize) to F. Fenema of Oklahoma A.&M.

Afternoon Inspection Trips

In the afternoon inspection trips were made with visits to the San Jacento Monument, Sinclair Refinery, a boat trip down the Ship Channel, and a trip to Galveston.

Student Conference of Group IV at Georgia Tech Held During A.S.M.E. Spring Meeting

THE tenth annual Southern Student Meeting of Group IV was held in Atlanta, Ga., March 30–April 1, simultaneously with the national A.S.M.E. Spring Meeting in that city.

Georgia School of Technology was the host for the meeting attended by 228 students and 27 faculty members from fifteen Southern colleges and three students from Toronto, Canada. Registration headquarters in the A.S.M.E. Lounge of the Mechanical Engineering Building at Tech opened Sunday afternoon for the early delegates, and continued through Monday morning.

Inspection trips on Monday were made to the Atlantic Brewery, the Atlantic Central Ice Making Plant, the Bauer Pottery, and the General Shoe Company's plant. Luncheon on Monday was in the Georgia Tech dining hall—Brittain Hall—with the chairman of the Branch, Jack Ouzts, presiding. Dr. M. L. Brittain, president of Georgia Tech, welcomed the visitors to the campus and Eugene W. O'Brien, chairman of the A.S.M.E. Standing Committee on Relations With Colleges gave a short informal talk.

Prizes for Technical Papers

The technical sessions of the conference were held in the Georgia Tech Y.M.C.A. Auditorium, the first on Monday afternoon having as its presiding officer H. B. Tomlin of Vanderbilt University, and the second on Tuesday morning, J. V. Kalb of the University of Kentucky. The papers were interesting and well delivered, resulting in the award of prizes as follows:

$35 to G. W. Gilmer, 3rd, of the University of Florida, for his paper "The Yacht Sail—A Problem in Aerodynamics."
$25 to Bruce E. Lewis, of North Carolina State College, for his paper "Locomotives of Tomorrow."
$15 to W. F. Hamlin, of the University of Tennessee, for his paper "A New Continuous Pressure-Cooker Oil-Expressing Unit."
$10 to C. K. Dillingham, of Vanderbilt University, for his paper "Development of Large Guns in the United States."
$10 (Old Guard Prize) to Hunter R. Hughes, Jr., of the University of Virginia, for his paper "The Field of Technical Writing."

Students were welcomed at all sessions of the A.S.M.E. Spring Meeting but were invited in particular to those held on Monday evening, covering power, education and training, and textiles.

Tuesday's Events

Tuesday was replete with events, starting with the breakfast for the honorary chairmen of the Branches and the faculty members in attendance, at which Dr. R. S. King, head of the mechanical-engineering department at Tech, presided. At this breakfast it was decided to hold the 1942 Student Conference of Group IV at the University of Tennessee in Knoxville.

Luncheon was held jointly with the members of the A.S.M.E. attending the Spring Meeting at the Atlanta Biltmore. E. C. Holdredge, of the University of Tennessee, presided and Lewis F. Gordon, assistant vice-president of the Citizens & Southern National Bank, spoke on "This Day's Opportunity." It was at this luncheon that the prizes for the best papers, previously mentioned, were awarded to the winners by Eugene W. O'Brien.

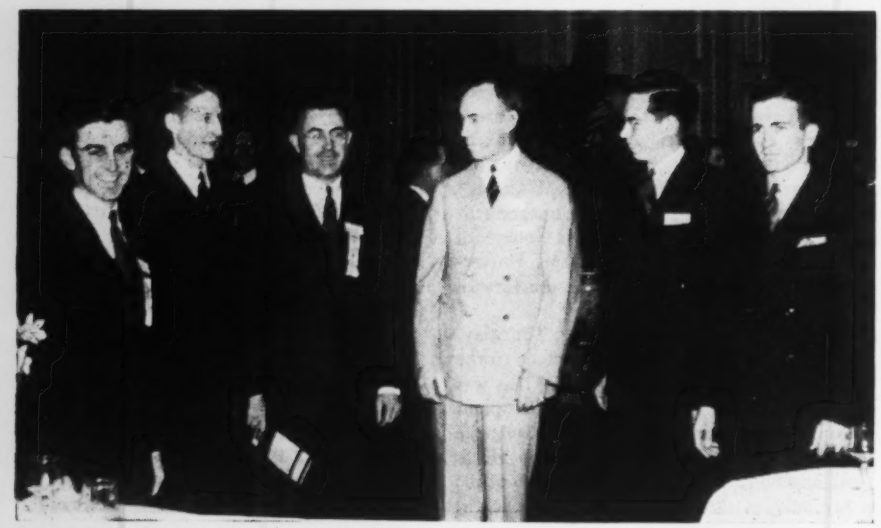
Door prizes were donated, one a Purolator Oil Filter, won by Irving West, of Virginia Polytechnic Institute, and the other an SKF slide rule won by Joe Horning of the University of Louisville.

Tuesday's inspection trips included visits to the Atlanta Incinerator, the Atlantic Steel Company, and the Georgia Power Company's Plant Atkinson.

The banquet of the Conference concluded the official doings. It was held in Brittain Hall. J. B. Buescher of Mississippi State College was toastmaster upon this occasion and the speaker was William A. Hanley, President of the A.S.M.E., who took as his topic "Looking Just Ahead." An informal dance followed at the ballroom of the Biltmore Hotel.

A Success

There was the general consensus of opinion that the Conference was not only an extremely interesting one but of particular value at this special time giving both students and members a chance to get acquainted with each other. Members were delighted with the capable handling by student presiding officers and the excellent papers presented, while the students enjoyed the technical sessions and hobnobbing in general with men out in industry in which they hope soon to be a factor.



JUST BEFORE THE LUNCHEON AT THE ATLANTA BILTMORE ON TUESDAY, APRIL 1

(Shows the officers of the Georgia Tech Student Branch with Eugene W. O'Brien, chairman of the A.S.M.E. Standing Committee on Relations With Colleges, and William A. Hanley, President A.S.M.E. From left to right are Jack Ouzts, chairman, W. Len Shipman, vice-chairman, E. W. O'Brien, W. A. Hanley, W. B. Lumsden, Jr., secretary, and J. E. Warrick, treasurer. Photograph was taken by staff photographer of the Georgia Tech *Technique*, Langinwalter.)

Branch Meetings

Alabama Engineers' Show

STUDENT MEMBERS of ALABAMA POLY BRANCH took part in the school's Engineers' Show held on March 26. The boys operated mechanical and steam laboratories and Diesel engines, made castings in the foun-

dry, and welded steel plates by means of arc and oxyacetylene welding.

ARKANSAS BRANCH obtained five new members at the March 7 meeting and thereby reached a new high in membership with a total of 28. From promises made at the meeting, it seemed that almost everyone would attend the Student Conference in Houston, Texas, March 28–29. Papers were presented by J. A. Toone, P. E. Franklin, and H. H. Clayton.

BRITISH COLUMBIA BRANCH members were allowed a maximum of ten dollars each by the Foreign Exchange Control Board so that they could attend the Student Conference at Seattle. During February, papers were presented by John Storey on "Fish-Oil Separators," and by Rex Parker on "Problems in High-Pressure, High-Temperature Piping."

Carnegie and Pittsburgh Joint Hosts

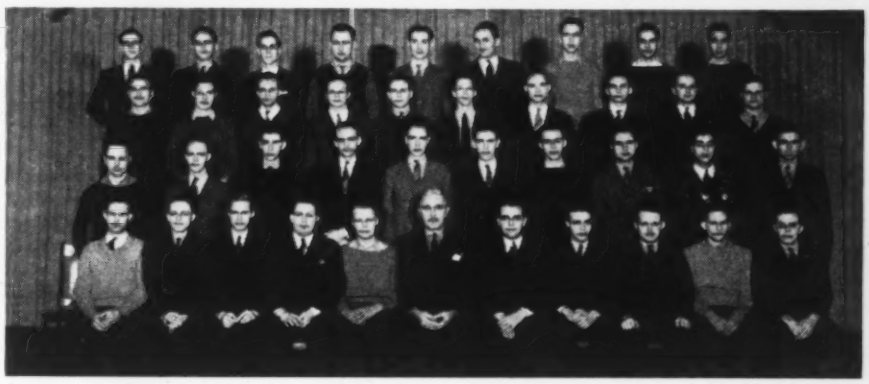
The Allegheny Student Conference of the A.S.M.E. is scheduled to be held May 7–9 in Pittsburgh with CARNEGIE BRANCH and PITTSBURGH BRANCH as joint hosts. Among the high lights of the conference will be inspection trips to the steel mills. Registration will take place in the only skyscraper university building in the world, the Cathedral of Learning. Conference committees are hard at work to make this affair the most enlightening and entertaining ever held in this part of the country. Members, juniors, and students of the Society are cordially invited to attend.

CINCINNATI BRANCH's two Irishmen and 82 other members honored St. Patrick on March 17 at a dinner meeting presided over by Eugene Feerer. The luck of the Irish was with the Branch because among the guests was John Pryor, a representative of the personnel department of the Goodyear Rubber Co., who was there to offer jobs to likely looking prospects. Speaker of the evening was Dean Gowdy who discussed the position of the engineering student in relation to the Selective Service Act.

C.C.N.Y. BRANCH featured at its March 6 meeting a talk on "Sheet-Metal Fabrication in the Aircraft Industry" presented by Gordon Strom, a faculty member of the N.Y.U. Guggenheim School of Aeronautics. There were 85 members and guests present.

MACHINERY HALL AT CARNEGIE TECH

SECTION ONE—A.S.M.E. STUDENT BRANCH AT UNIVERSITY OF CINCINNATI



SECTION TWO—A.S.M.E. STUDENT BRANCH AT UNIVERSITY OF CINCINNATI

CLARKSON BRANCH members and guests numbering 40 were present at the March 7 meeting to hear Maxwell C. Maxwell talk on "Home Defense," which dealt with the history and mechanics of locks. His paper was vividly illustrated with working replicas of old and new locks and an interesting motion picture.

CLEMSON BRANCH had a turnout of 94 members and guests on Feb. 3 for a meeting at which Dean Robert L. Sackett was the speaker. He urged the group to keep level heads and not be too greatly influenced by the European situation. On Mar. 11, G. F. Benjamin, student member, gave a paper on Diesel engines, covering the principles of operation and applications in various industries.

COLORADO MINES BRANCH devoted practically all of February and March getting ready for the Rocky Mountain Student Conference of the A.S.M.E., April 17–18, at which it will act as host. Part of the program will include an inspection of the Union Pacific Railroad's *City of Denver*, a streamlined train.

Colorado State Session Attracts 78

The Fort Collins Engineering Club and the chapters of the A.S.C.E. and A.I.E.E. were guests of the COLORADO STATE BRANCH at the March 9 meeting. Prof. J. C. Reed, of the Colorado School of Mines, presented slides and motion pictures of laminar and turbulent flow of water in pipes based on his work at the University of Illinois.

COOPER UNION BRANCH (day) heard an interesting paper on "Accelerometers" presented at the March 13 meeting by Robert Roalef. He reviewed the various devices which are used to measure acceleration, pointing out their unsuitability to practical adoption, and then described a new type of device designed by him. The theoretical and constructional principles of his accelerometer were described as well as the utilization with it of integrating devices also developed by the speaker.

COOPER UNION BRANCH (evening) featured a paper by Gustave Sedat on "The Proper Selection of Heat Transfer Equipment" at the March 27 session. He discussed in some detail the specifications which the purchaser of heat-transmission equipment must supply to the manufacturer if the latter is to furnish a satisfactory piece of equipment.

Talk on Defense Training Courses

CORNELL BRANCH members learned about the National Defense Program training courses being given at colleges and vocational schools from Dr. Arthur S. Adams, assistant to the dean of engineering, at the meeting of March 5. According to him, engineering courses are being given in 115 engineering colleges in connection with national preparedness which has brought about a great need for engineers. Congress has set aside $9,000,000 for these courses.

DELAWARE BRANCH has a small membership which is an active one despite its size. Besides holding meetings, there have been some inpsection trips.

During March, papers were presented before

A.S.M.E. STUDENT BRANCH MEMBERS AT UNIVERSITY OF DELAWARE

the GEORGIA TECH BRANCH by Leon D. Rocamora on "The Chrysler Hydramatic Drive," by J. Max Langley on "Yard-Office Communications," by Jack Tyler on "Temperature-Control Instruments," and by Julian Garrard on "Power-Plant Installations in Small Boats."

IDAHO BRANCH has made arrangements whereby members will be given an opportunity to utilize the machine tools in the mechanical-engineering laboratory every Thursday evening for individual projects. At the March 19 meeting, Melvin McEuen talked on aircraft production based on his experience at the Douglas Aircraft Corporation.

ILLINOIS TECH at the meeting of Feb. 28 had Everett S. Lee, General Electric Laboratories, describe lightning which lasts only seven millionths of a second. The measurement of the high voltages in lightning can be accomplished by means of an oscilloscope. Another interesting machine described by Mr. Lee was an electric color analyzer which prepares a graph of the percentage of color in an article.

ILLINOIS BRANCH following election of officers for the second semester during the meeting of March 12 learned from Professor Seely about the research projects now being studied in the school's testing laboratory. An audience of 105 members was present.

IOWA BRANCH members were given a lecture on life insurance by John Partington at the March 5 session. At the March 12 meeting, James Mahan, class of 1937, conducted an informal discussion on the Navy Air Corps.

KANSAS BRANCH committees were appointed by Dorus Munsinger, chairman of the Branch, at the March 27 meeting to handle plans for the school's engineering exposition on April 19 and to get papers ready for presentation at the A.S.M.E. Student Conference.

KENTUCKY BRANCH selected Milton Rice on Feb. 28 to give a paper at the Atlanta Student Conference. Since then he has presented his talk several times before the group in order to acquire poise in delivery and to do a good job at the conference.

LOUISVILLE BRANCH held an elimination contest on Feb. 28 to select its representative at the Student Conference. After listening to papers by Wener, Strother and Altman, the members chose the last speaker for his paper on "Electrical Internal-Combustion-Engine Indicators."

Saturated Water at Michigan

On March 4, MICHIGAN BRANCH held a meeting at which Max Benjamin and John Miller, The Detroit Edison Co., presented the results of their recent investigation of "The Flow of Saturated Water Through Pipes and Orifices." The problem concerned the phenomenon of water saturated with heat partially flashing to steam when a slight pressure drop occurs. This often occurs in a pipe leaving a feedwater heater. Results of tests were discussed to show how remedies were developed.

MICHIGAN MINING BRANCH at the March 19 meeting showed a sound motion picture of the research, tests, and inspection behind automobiles and followed this with a paper by Robert Arms on "Snow Removal in Northern Michigan."

MISSOURI BRANCH had an inspection trip on Feb. 22 to the newly constructed sewage-disposal plant of Columbia, Mo. On March 5, 49 members made an inspection trip through the A. P. Green Fire Brick Co. plant at Mexico, Mo.

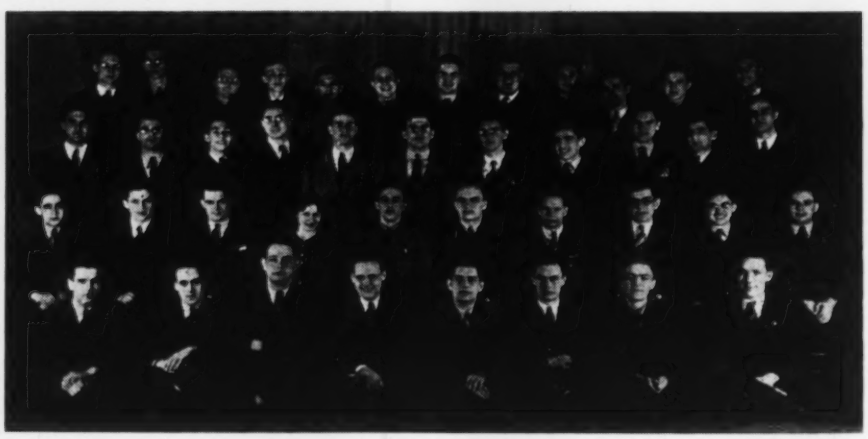
MONTANA STATE BRANCH had two papers given at the Feb. 27 session. Roy Peterson described the work of the U. S. Forest Service fire rangers and their work in preventing and fighting fires. Walter Thieme described the various equipment used in fighting forest fires.

Nebraska Selects Speakers

Representing NEBRASKA BRANCH at the Student Conference in Omaha will be Roy Gatch, who will give a paper on "The Continuous Combustion Gasoline Turbine," and Leo Butler, who expects to describe "Steel at High Temperatures." These selections were announced at the April 2 meeting at which Maj. A. T. Lobdell, former head of the Nebraska Highway Department, talked on Nebraska highways and their relation to National Defense.

NEVADA BRANCH presented Ernest J. Sweetland as the speaker at the Feb. 27 meeting. His paper was entitled "Inventions." He discussed some of his own patents and then told the boys how to secure a patent.

NEWARK BRANCH'S meeting of March 4 had a small attendance of only 30 due to examinations and homework. However, the total membership as of that date was 138. J. P. Headden, vice-president of the Purolator



COOPER UNION STUDENT BRANCH (DAY SECTION)

A.S.M.E. STUDENT BRANCH OF NEWARK COLLEGE OF ENGINEERING

Co. gave a paper on "Practical Plant Management" in which he brought out that the two essential things for successful management are common sense and a knowledge of current events.

NEW HAMPSHIRE BRANCH celebrated St. Patrick's Day on March 17 with a banquet for the members. Following a sumptuous feast, the members discussed the work of the State's engineering experiment station and the work carried out for different industries.

NEW MEXICO BRANCH helped to celebrate the opening of the new aeronautical-engineering building with a house-warming dance in January. On Feb. 25, Don Singer delivered a paper on new trends in the design of steam locomotives. Philip Whitener gave a talk on plastic airplanes.

NEW MEXICO STATE BRANCH held its St. Patrick's Ball on March 22. During the day demonstrations were given by the members in metallography, steam power, drafting, foundry work, and machine-shop practice.

N.Y.U. Discusses Airfoils

The March 5 meeting of the N.Y.U. BRANCH (aeronautical) was high lighted with a lecture by Prof. John K. Vennard on the subject of shock waves formed by high-speed airfoils which affect speed and general design. He also discussed the derivation of the critical Mach number which determines the velocity at which the shock wave begins to form about the airfoil. The variation of the critical velocity with such types of airfoils as thin, thick, and high cambered were noted.

N.Y.U. BRANCH (mechanical) did its part in engineering demonstration day on the campus by having its members operate the machinery and equipment in the mechanical-engineering laboratory.

N.Y.U. BRANCH (evening) met on March 5 and featured a talk by John Newton, Carrier Corporation, on the various aspects of modern air conditioning.

NORTH DAKOTA STATE BRANCH held an inspection trip on Feb. 26 to the Moorehead Municipal Power Plant. Members were given complete descriptions of each individual piece of equipment in the plant by the superintendent.

OHIO STATE BRANCH had attendances of more than 100 at meetings held on Feb. 21 and Feb. 28. At the first one, Col. H. C. Mulenburg, air officer of the 5th Corps Area, discussed the opportunities in the Air Corps for college men. At the latter one, Henry B. Sherman, department of engineering drawing gave the histories of famous engineers.

OREGON STATE BRANCH held its first meeting of the spring term on March 26. After making plans to attend the Student Conference, a film, "Sinews of Steel," depicting the different processes involved in the production of wire rope and cable, was shown.

A.S.M.E. STUDENT MEMBERS AT COLORADO STATE COLLEGE

Pratt Inspects LaGuardia Field

Through the courtesy of American Airlines, members of PRATT BRANCH on March 15 were given the rare privilege of inspecting the company's hangars and shops at LaGuardia Field, North Beach, N. Y. Everybody learned something on this trip.

R.P.I. BRANCH members learned about lock picking from Maxwell C. Maxwell when he gave a paper on locks at the March 4 meeting. Of course, he also covered the history of locks and their uses yesterday and today. There was an attendance of 75 members.

RICE BRANCH welcomed back an alumnus of the class of 1932 when Douglas Ragland attended the March 19 meeting and spoke on "Directional Drilling of Oil Wells." According to the speaker, this method is now being used not only in the oil fields but also for drilling under large bodies of water.

ROSE POLY BRANCH at the meeting of March 10 had Harold B. Frist speak on new motor supercoaches and Arnold Jones discuss an "Open Letter to the President." Discussion followed each paper.

SANTA CLARA BRANCH after making plans at the Feb. 27 meeting for attending the Student Conference followed this with a paper on the S.S. *America* by George Sharp.

U.S.C. Members Eat In

In order to conserve time, UNIVERSITY OF SOUTHERN CALIFORNIA BRANCH members had their lunches brought to the meeting room on March 26 by a caterer. As soon as he finished eating, Arthur P. Adamson gave a paper on "Entropy" in which he defined the subject by quoting from philosophers, mathematicians, and physicists.

S.M.U. BRANCH members discussed a lot of business at the March 5 meeting, including engineer's day at the school, the Student Conference, cash prizes for papers, a joint meeting with the A.S.M.E. Local Section, and an exhibit.

TENNESSEE BRANCH invited the entire engi-

MEMBERS OF THE MECHANICAL DIVISION OF THE A.S.M.E. STUDENT BRANCH AT NEW YORK UNIVERSITY

(Officers are four center persons in front row, left to right: A. Pellino, secretary, H. Haglund, president, Irving Buchalter, treasurer, and Erwin Loewen, vice-president.)

GRADUATING 1941 A.S.M.E. STUDENT MEMBERS, UNIVERSITY OF NEBRASKA

STUDENT BRANCH AT UNIVERSITY OF NEW MEXICO

neering student body to the auditorium on March 7 to hear an address by Dean Robert L. Sackett. Approximately 200 members and guests heard him discuss the characteristics of a good engineer and the need of getting along with one's fellow men. At the Feb. 27 session, W. F. Hamlin was awarded a cash prize of $7 for the best paper given during the term and W. T. Moorman received $5 for the second best paper.

TEXAS BRANCH showed a motion picture about Boulder Dam at the meeting of March 10, attended by 49 members and guests.

TEXAS A.&M. BRANCH featured a paper on "New Heat-Treating Developments" given by Harry W. McQuaid at the Feb. 27 session, and a sound movie on "Wire Rope" and a paper on the same subject presented by F. E. Tuxworth at the March 13 meeting.

WASHINGTON STATE BRANCH devoted its meeting of Feb. 27 to committee appointments for the second semester and to the showing of motion pictures on "Diesel Engines" and "Boulder Dam."

WASHINGTON BRANCH spent the better part of the March 17 meeting in assigning projects to juniors and seniors in connection with the "Engineers' Days," March 28–29.

Francis J. Cole Scholarships

UNDER the will of Mrs. Francis J. Cole, the California Institute of Technology recently received a fund of $75,000 to establish the Francis J. Cole Scholarships. Mrs Cole's will specified that the income from the fund be divided equally among three scholarships, one in physics, one in electrical engineering, and one in mechanical engineering.

Mr. Francis J. Cole, for whom this memorial has been established, died in 1923, a short time after retiring as chief consulting engineer of the American Locomotive Company. During his active career he introduced many important innovations in locomotive design. He was for many years a prominent member of The American Society of Mechanical Engineers.

Iowa Summer Management Course, June 9–27

THE University of Iowa, Iowa City, Ia., is offering for the third summer a special three-week course, June 9 to 27, 1941, for people in industry interested in comprehensive training in production planning—routing and scheduling of work, motion and time study, layout of manufacturing equipment, waste elimination, and related subjects. Executives and engineers from 30 different industries attended the course last summer.

The course will be under the direction of Ralph M. Barnes, member A.S.M.E. Assisting him will be six university instructors and lecturers and eight visiting managers and engineers from industry who will conduct forums on practical production problems.

College of Applied Science at Syracuse University Has Fortieth Anniversary

AT the fortieth anniversary celebration of the College of Applied Science at Syracuse University, L. K. Sillcox of the New York Air Brake Company and Harte Cooke of the American Locomotive Company represented the A.S.M.E., having been appointed honorary vice-presidents for this occasion by President Hanley.

Engineering Colleges Not Likely to Graduate Class of 1942 Earlier Than Usual

IT IS unlikely that the U. S. Office of Education will recommend to the Congress an appropriation to make possible operation of engineering colleges during the summer of 1941 in order to accelerate graduation of young engineers before the usual June, 1942, date, according to D. B. Prentice, member A.S.M.E., president Rose Polytechnic Institute, and president S.P.E.E.

Mr. Prentice attended a meeting of the Advisory Committee on Engineering Defense Training of the U. S. Office of Education in Washington on March 8, at which time he presented a report of the S.P.E.E. Committee on Acceleration of the Regular Engineering Programs in which the matter of advancing the graduation date was discussed. The Committee was appointed by Mr. Prentice as the result of a request to S.P.E.E. that it consider the feasibility and advisability of accelerating the regular engineering programs of engineering colleges. The report expressed the Committee's opinion that some plan should be inaugurated for accelerating the graduation of engineering students, particularly the class of 1942. It summarized the committee's views on the factors involved, the difficulties to be faced, and the probable cost ($5,000,000 if the proposed speed-up plan were to be made compulsory for all engineering students of the class of 1942 and 50 per cent more if the plan were to be operated in parallel with the normal curriculum). It pointed out that the decision must be made promptly, that the accelerated courses should be operated as part of the present Engineering Defense Training program, and that the government should make provision for loans to students.

Application of the proposed program for the summer of 1941 to members of the class of 1943 was held by the Committee not to be advisable, for reasons given in its report. The report also stated that it would be unwise to start the classes of 1944 and 1945 on a continuous three-year course of study.

In his report on the Washington meeting of March 8, Mr. Prentice said that it was felt that an extension of the present Engineering Defense Training program by the engineering colleges during the summer months will be more effective than a speed-up for the regular classes.

National Board of Fire Underwriters Celebrates 75th Anniversary

CONCURRENT with the 75th anniversary of its founding in 1866 by capital-stock fire-insurance companies, the National Board of Fire Underwriters has called upon more than 40,000 nationally prominent men and groups to unite in a vigorous program between now and May 28, to create a stronger national defense through a more efficient fire defense.

Contacts with these men and groups have already been established by W. E. Mallalieu, director of anniversary activities for the National Board of Fire Underwriters, and an activities center at 85 John St., New York, N. Y., will answer all requests for information on fire prevention and fire control from persons and groups cooperating in this vital national-defense program.

The nation-wide activities with which the National Board of Fire Underwriters will commemorate this 75th anniversary will continue until May 21, with the week of May 21–28 to be known as Anniversary Week.

The activities will come to a climax with three important functions at the Waldorf-Astoria—a dinner on May 28, at which a speaker of national prominence will stress national defense and fire insurance; two luncheons on May 27 and 28, at which outstanding speakers will stress the contribution made by capital-stock fire-insurance companies, 1792–1941, to national defense, to America's development, to fire protection and fire prevention.

Industrial Diamond Review Established

THE initial issue of the *Industrial Diamond Review*, a newly established supplement to *The Gemmologist*, has recently been received. According to the announcement received with the first issue, it is the intention of the publishers, N.A.G. Press, Ltd., London, "to produce the *Review* monthly and to devote its pages to a review of contemporary literature and the publication of original articles dealing with the use of diamonds, gem stones, and hard materials as cutting tools, dies, bearings, and abrasives, in industry, and particularly their application to engineering."

M.I.T. to Be Host for Eastern Photoelasticity Conference Cambridge, June 12–14

THE thirteenth semiannual meeting of the Eastern Photoelasticity Conference will be held on June 12–14, 1941, at Cambridge, Mass., under the auspices of the department of mechanical engineering at the Massachusetts Institute of Technology.

All inquiries should be addressed to W. M. Murray, Room 1–321, the Massachusetts Institute of Technology, Cambridge, Mass.

Hydrology Conference, State College, Pa., June 30 to July 2, 1941

A conference on hydrology is to be held at State College, Pa., from June 30 to July 2, 1941, under the joint sponsorship of the section on hydrology of the American Geophysical Union, the Civil Engineering Division of S.P.E.E., the Committee on Hydrology of the American Society of Civil Engineers, and The Pennsylvania State College. Inquiries regarding the conference may be addressed to F. T. Mavis, State College, Pennsylvania.

R. L. SACKETT AND CHARLES E. LUCKE PLACE A WREATH ON THE GRAVE OF OLIVER EVANS, ENGINEER, 1755–1819, AT TRINITY CEMETERY, NEW YORK, N. Y., APRIL 15, 1941

(The monument to Oliver Evans, erected by Greville Bathe, of Philadelphia, Evans' biographer, and sponsored by the American Scenic and Historic Presentation Society, was unveiled a year ago, at which time Dr. Lucke delivered an address on Oliver Evans. The inscription on the monument describes Evans as an engineer "whose pioneer work in the application of high-pressure steam to locomotion and industry with the introduction of automatic machinery in flour milling; whose creative writings on technical and scientific subjects, and enterprise as a manufacturer and promoter of useful inventions place him in the front rank of those who laid the foundations of America's greatness as an industrial and scientific nation.")

A.S.T.M. Organizes New Standing Committee on Electroplating

WITH the organization by the American Society for Testing Materials of the new Committee B-8 on Electrodeposited Metallic Coatings effected in March, plans that had been under discussion last year on realignment of the Society's work on electroplating have been put into effect. The preliminary statement of the scope of the work of the Committee follows: The formulation of specifications and methods of test for electrodeposited metallic coatings with the exception of zinc and cadmium applied to steel.

The following specifications, formerly under the jurisdiction of Committee A-5, have been assigned to this new committee:

Tentative Specifications for Electrodeposited Coatings of Nickel and Chromium on Steel (A.S.T.M. A 166-40 T).

Tentative Methods of Test for Local Thickness of Electrodeposited Coatings on Steel (A.S.T.M. A 219-40 T).

The committee took under immediate consideration standards that have been under development in Committee B-3 and it is proposed to recommend later proposed new specifications covering:

Electrodeposited Copper-Nickel-Chromium Coatings on Zinc and Zinc-Base Alloys.

Electrodeposited Nickel-Chromium Coatings on Copper and Copper-Base Metals.

Industrial-Hygiene Meeting, Pittsburgh, May 5–9

A "postgraduate" Institute of Industrial Medicine and Industrial Hygiene will be held in Pittsburgh, May 5 to 9. The Institute marks the 26th annual meeting of the American Association of Industrial Physicians and Surgeons, and the second annual meeting of the American Industrial Hygiene Association. T. F. Hatch, chairman of the A.S.M.E. Safety Committee, is treasurer of the last-named association. Majority of the sessions will be held at the William Penn Hotel.

A series of important dry clinics in Industrial Medicine and Surgery will be held at Mercy Hospital on the first day, Monday, May 5.

One of the high lights of the day will be a consideration of diagnosis and treatment of various "Industrial Backs."

Wednesday morning will be devoted to recent research on such subjects as carbon-monoxide poisoning; effects of radiation from an ophthalmologic viewpoint; and various aspects of industrial lead exposures and industrial lead poisoning.

Tuberculosis problems will be the main topic of discussion on Wednesday afternoon, including engineering preventive methods in the control of tuberculosis, and also bacteria in the air, and problems of disinfection and ventilation.

A banquet will be held Wednesday evening at which principal speakers will be Dr. Irving Abell, Chairman of Health and Medical Committee, Federal Security Agency, discussing the role of industrial medicine and hygiene in national defense; and V. O. Knudsen, dean of the Graduate School, University of California, Berkeley, speaking on the topic "Noise and Hearing."

Industrial ventilation problems will be considered on Thursday morning. Industrial hygiene dust studies are scheduled for Thursday afternoon. Papers will also be read on particle sizes of dusts as found in various industries; animal and petrographic studies on talc dusts; and silicosis among naval foundrymen.

The Institute concludes its symposiums on Friday afternoon with discussions of the following subjects: controlled radium hazards; phosphorous toxicology; biochemistry of carbon bisulphide; new synthetic chemical; toxicity of 1-1 dichlor-1-nitro-ethane; toxicity of methyl silicate; toxic effects on animals of methyl, ethyl, and butyl methacrylates.

Misleading Solicitation by Photographers

NEITHER The American Society of Mechanical Engineers nor the editorial staff of MECHANICAL ENGINEERING authorizes commercial photographers to secure portraits of members. Solicitation of members by certain photographers with the statement or intimation that the Society has requested prints has been reported repeatedly at headquarters. In no case has such solicitation ever been authorized.

A.S.M.E. $1-a-Year Men in OPM

A recently published list of dollar-a-year men employed in the Office of Production Management contained the names of the following A.S.M.E. members:

WILLIAM L. BATT, president SKF Industries
GANO DUNN, president J. G. White Engineering Corporation
A. B. EINIG, Motch & Merryweather Machine Company
GEORGE J. MEAD, director United Aircraft and Transport Corporation
JOHN C. PARKER, vice-president Consolidated Edison Company of New York, Inc.
C. OLIVER WELLINGTON, partner, Scovell, Wellington & Co., public accountants
DEXTER S. KIMBALL, Cornell University
WILLIAM E. WICKENDEN, Case School of Applied Science
JAMES F. TOWERS, Ford, Bacon & Davis

J. F. Barkley Represents the A.S.M.E. at Safety Meeting

AT the annual council meeting of the Joseph A. Holmes Safety Association on April 15, 1941, the A.S.M.E. was represented by J. F. Barkley, supervising engineer of fuel economy service in the Bureau of Mines and a member of the Society. The meeting was held in the conference room of the Bureau of Mines in the Interior Building.

Men and Positions Available

Send inquiries to New York Office of Engineering Societies Personnel Service, Inc.

29 W. 39th St. New York, N. Y. | 211 West Wacker Drive Chicago, Ill. | 57 Post Street San Francisco, Calif. | Hotel Statler Detroit, Mich.

MEN AVAILABLE[1]

MECHANICAL ENGINEER, B.S. in M.E., 30. Five years' experience as steam-turbine designer. Desires position on engineering staff of continuous process or chemical industry. Maintenance, operation, or development. Now employed. Me-628.

JUNIOR EXECUTIVE. Desires position with organization manufacturing precision machinery or machine tools. Five years in research division of office-machinery manufacturer. Also, experience in practical machine work, drafting, and designing. Me-629.

MECHANICAL AND ELECTRICAL ENGINEER, 37, married. Eleven years' experience in development and design of intricate mechanisms, automatic control, medium-sized machinery. Creative ability. Now employed, seeks responsible position. Me-630.

MECHANICAL ENGINEER, M.E. degree (R.P.I.) with over 17 years' intensive industrial experience covering production, costs, management, including sales promotion, etc. Present position, general manager of well-established woodworking concern. Desires position with greater opportunity for achievement. Me-631.

GRADUATE ENGINEER, 39. Fifteen years of electromechanical machine design, industrial-plant layout, design and supervision of construction of production equipment, heating, ventilating, refrigerating, air conditioning, electric power. Metropolitan New York preferred. Me-632.

GRADUATE MECHANICAL ENGINEER, '37; 33; citizen. Three years' experience in design and layout, heating, ventilating, and air-conditioning systems; dust-collector system, general piping for factory and industrial process. Now available. Me-633.

MECHANICAL ENGINEER, B.S. degree, 25; production, time study, costs. Eighteen months textiles. Twenty-one months machine costs. Strong on cost procedure. Desires time study, preparatory to cost work. Now employed. Location immaterial. Me-634.

[1] All men listed hold some form of A.S.M.E. membership.

(A.S.M.E. News continued on page 418)

Smooth—in appearance, smoother in design! Notice how the Carrier Streamlined★ Duct adds to the appearance of the beautiful hat salon of Famous-Barr & Co., St. Louis, the world's most completely air conditioned department store.

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✔ BETTER LOOKING
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Rorabaugh-Buck D. G. Co., Wichita, Kansas
Montgomery-Ward Stores
Houston, Texas
Fresno, Calif.
Wichita, Kansas
Peoria, Ill.
Kansas City, Kansas
S. S. Kresge Store, Danville, Ill.
S. S. Kresge Store, Peoria, Ill.
Ardis Building, Shreveport, La.
10 John R. Thompson Restaurants

AT LAST—here's the practical answer to the ductwork problem faced when air conditioning existing office buildings, department stores, hotels, restaurants and other spaces where appearance is important. Carrier Streamlined★ Ducts now perfected after years of experimentation and actual use in leading buildings—are completely free of outside seams or hangers. In appearance they are "almost like a beam"!

LOWER COSTS

In addition to improved appearance, the new Streamlined★ Ducts eliminate the extra cost of concealing ductwork with metal lath and plaster. Carrier outlets, having removable core, provide easy access for cleaning duct interior. Furthermore, jobs are much tighter, thus automatically making the entire air conditioning system more efficient . . . headroom is increased . . . and a more decorative paint finish can be selected to blend in with existing design. Don't delay. You should get all the facts on this important new development in air conditioning immediately. Call your Carrier Representative, or send in the coupon.

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"Weather Makers to the World"
(In Canada: 30 Bloor St., West, Toronto, Ont.)

Please send full details on the new Carrier Streamlined★ Ducts—and how they save on costs.

Name .....

Company .....

Address .....

MECHANICAL ENGINEER, 23, B.M.E., 1940. Six years' experience in design, drafting, and testing of steam-boiler parts and oil burners. Machine-shop and sales-engineering experience. East preferred. Me-635.

MECHANICAL ENGINEER, B.S.M.E., 30, married, in excellent health. Employed now in supervisory position but desires new connection. Six years' boiler and power-plant maintenance and operating experience. Me-636.

MANUFACTURING EXECUTIVE, 31, M.E. Eight years' experience, methods, development, plant layout, tool design, operation planning, production supervision, equipment investigation and purchase, cost estimating, production planning, personnel problems. Successful record. Now employed. Me-637.

MECHANICAL ENGINEER, 42, experienced in plant engineering, design, layout, installation, and maintenance of industrial and steam-plant equipment. Desires connection with either food, chemical, or utility company. Me-638.

MECHANICAL ENGINEER, 28, married. Four years teaching mechanical engineering. Three years' industrial experience in machine design and production methods. Now employed as assistant professor in mechanical engineering. Available, September, 1941. Location, immaterial. Me-639.

EXECUTIVE AND INDUSTRIAL ENGINEER, graduate Cornell University, E.E. Fifteen years' management and professional experience. Installed and operated successfully cost-accounting and production-control systems. Qualified in personnel, maintenance, purchasing, waste-elimination, wage, and key-man incentive programs. Me-640.

MANUFACTURING EXECUTIVE, 42, mechanical engineer with exceptional background. Ten years as tool and gage maker; 4 years engineering design; 12 years as factory superintendent. Excellent mechanic, knows tools and production methods on high-precision products. Me-641.

POSITIONS AVAILABLE

SALESMEN, not over 30, graduate mechanical or metallurgical engineers. Should have some sales experience in steel products or allied lines. Apply by letter, supplying full particulars, experience, and training, in own handwriting with recent photograph. Pennsylvania. Y-6653.

INDUSTRIAL ENGINEER, young, graduate mechanical preferred, who has had some experience in production or wishes to develop in industrial-engineering phase of manufacturing. Connecticut. Y-7729.

MAINTENANCE ENGINEER, 25–32, graduate mechanical, with several years' machine maintenance or construction experience. Thorough knowledge of machine design, mechanical drawing, and general machine and equipment operation. Also knowledge of materials used for equipment construction. Must have good personality, initiative, and ability to develop into supervisory position. Prefer married man. Salary, $200–$225 a month. Middle West. Y-7738-D

GRADUATE ENGINEER, not over 40, with either mechanical or electrical degree. Must have thorough knowledge of machine-shop practice on heavy machinery tools, some drafting-board work, and the ability to demonstrate machines of manufacturer to customers. Must have sales personality. Salary, $2500–$3000 a year. Position is permanent. New England. Y-7741.

PROFESSOR OF MECHANICAL ENGINEERING, qualified by personal qualities, education, teaching, and practical experience to serve as department head in engineering college of eastern university. Y-7743.

MECHANICAL ENGINEER with several years' factory experience, to cooperate with tool designers, inspection and purchasing departments, and factory foremen in putting into production new types of apparatus developed. Must have some design experience and be able to choose tolerances for interchangeable and selective assembly of closely fitted parts with due regard for performance and factory convenience. May be called upon to prepare specifications and to act for the engineering department in dealing with suppliers of machine tools, materials, and finished parts. Test experience with automotive engines and accessories is desirable but not essential. Must be citizen. Apply by letter, giving full information. Salary open. Location, East. Y-7747.

SALES ENGINEER, 23–35, graduate mechanical or electrical, who has had mechanical experience, to sell power-plant equipment; must have knowledge of power-plant operation and be able to service equipment. Position permanent. New England. Y-7753.

MECHANICAL ENGINEER, 30–50 with wide experience on tooling, to work with general manager and production manager of manufacturing company. New England. Y-7756.

SUPERVISOR of die setters, 25–40, for steel-fabricating plant. Must be able to handle men and be familiar with all phases of die setting on presses from 30 to 750 tons capacity. Should be capable of following work through the shop and assisting the engineering department in keeping die and product drawings up to date. Must be first-class man with several years' experience in handling position of this kind. Salary, $2100–$3000 a year. Ohio. Y-7764-D.

MECHANICAL ENGINEER who has a knowledge of and ability for designing heating and ventilating equipment, refrigerating equipment; and Diesel power plants from 100 to 1000 kw for field fortification work. Salary $3800–$5400 a year. South. Y-7771.

MAINTENANCE ENGINEER, 28–36, graduate mechanical, who has had a few years of versatile mechanical maintenance experience since graduation. He must have ability to diagnose complex machine breakdowns and keep plant in operation. Opportunity to develop in fast-growing industry. Prefer married man. New Jersey. Y-7791.

CHECKER experienced on tool design (heavy and medium ammunition). Salary, $60–$65 week. Pennsylvania. Y-7802.

DRAFTSMEN who have had from five to ten years' experience in chemical-plant layout. Specialized experience desired as follows: equipment arrangement in structures, piping for process and services, and design and layout of standard machine elements, transmission equipment, conveyers, etc. Salary, $3300 year. New Jersey. Y-7803.

TOOL ENGINEER, preferably college graduate with some manufacturing experience, particularly with reference to design, manufacture, and use of small dies, jigs, and fixtures. Should be able to analyze design from standpoint of production tooling covering cost, simplicity, and durability of dies. Knowledge of shearing and punching, qualities of all kinds of sheet materials, ferrous, nonferrous, insulation, and some plastics desirable. Company manufactures automotive specialties such as electromagnetic equipment including relays, voltage regulators, switches, etc. Salary, $3600 year to start. Middle West. Y-7815.

TOY DESIGNER who possesses knowledge of manufacturing methods and costs besides being good designer and model maker. He must also have the originality as well as the imagination which would enable him to see problems from the sales angle. New England. Y-7828.

ASSISTANT PURCHASING ENGINEER, 30–35, graduate mechanical, to follow up in purchasing department. Some purchasing experience desired. Also must be experienced in dealing with men. Salary open. Permanent. New York, N. Y. Y-7839.

MECHANICAL ENGINEER, young, experienced in design and development of air-cooled engines by single-cylinder methods. Permanent position. Applicant should state salary expected. Pennsylvania. Y-7878.

MECHANICAL ENGINEER, experienced and competent in operation of machine-tool shops. Must be able to evaluate capacity of all types of machine tools and assign production work to such machines. Salary, $5000 year. East. Y-7896.

INDUSTRIAL ENGINEER, 26–35, who has had about five years of time-study and engineering experience in three large industrial companies whose engineering work is known to be sound. The major portion of the applicant's work should have been concerned with cost analysis, layout, equipment, methods, etc. Should possess intelligence, administrative ability, selling personality, and be capable of organizing and directing the work of assistants and of developing them for larger responsibilities. Salary, $2600–$3600 a year. South. Y-7897.

MECHANICAL ENGINEER, 35–45, who has had considerable experience in time study and estimating machine-shop job costs. Must be able to work from blueprints. Salary, $3600–$4000 year. New York metropolitan area. Y-7918.

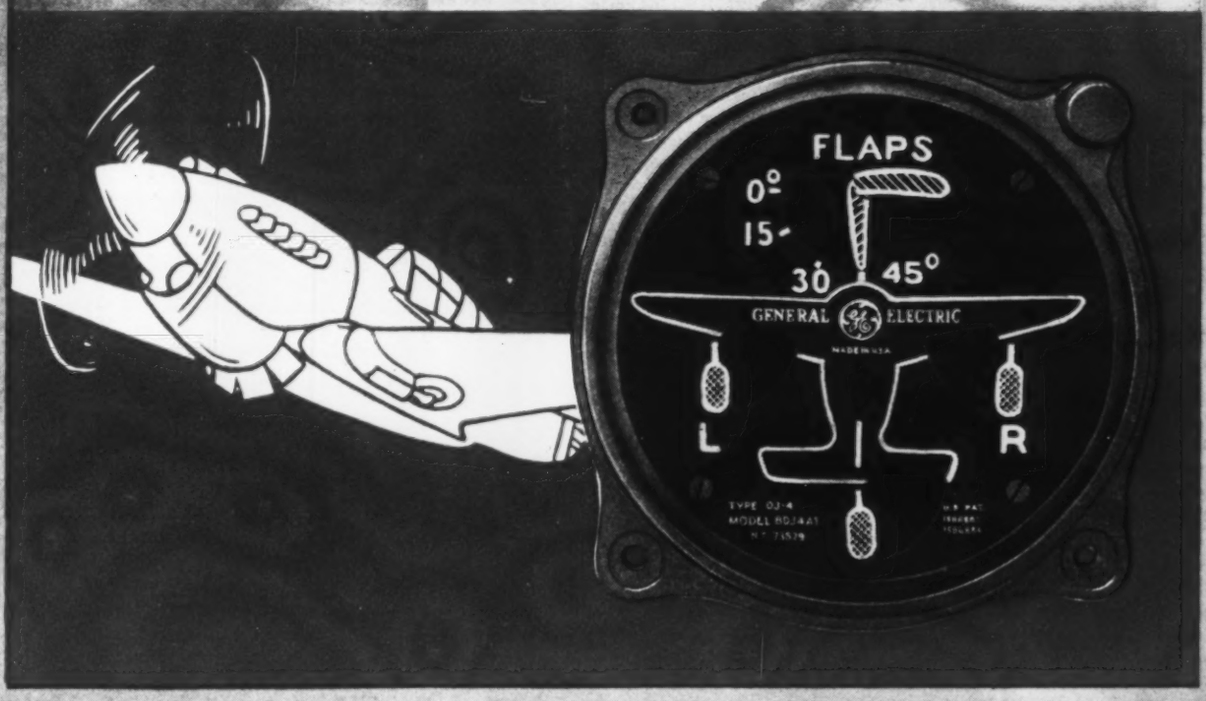
CHIEF INSPECTOR who has had background of practical machine-shop experience as well as theoretical knowledge. Will be in complete charge of inspection in a gun-manufacturing plant. Salary, $3000–$3600 a year. New York metropolitan area. Y-7919.

INDUSTRIAL ENGINEER who has had time-study and cost-analysis experience. Salary $1800–$2700 a year. Also require young engineers who are interested in industrial-engineering work; experience unnecessary. Salary open. Pennsylvania. Y-7920.

GRADUATE ENGINEER who has had wide experience in shop work and personnel rela-

(A.S.M.E. News continued on page 420)

To Measure POSITION ELECTRICALLY



Happy landings—with G-E instruments

WHEN driving your automobile through tight quarters haven't you often stretched your neck to see just how much clearance your fenders had? But think of a pilot—about to land a modern plane—who can't see his retractable landing gear! He has to know if the wheels are down and the wing flaps are in the correct position.

Although the pilot can't see these parts of the plane, he has a means of *knowing* their position at all times. The electric instrument shown above tells him exactly the position of wheels and wing flaps. Without this visual indication he could only hope that the mechanism had operated properly.

The operation of this instrument, developed by G-E engineers for this specific purpose, is very simple. Small, lightweight, d-c Selsyns connected to the wheels and flaps transmit their movement directly to the instrument. The pictorial indication on the dial gives the position of the three wheels and both flaps at a single glance.

Aircraft instruments require no greater accuracy nor positive operation than do the many other instruments General Electric makes for such common but all-important measurements as motor current, voltage, power-factor, frequency, resistance, etc. While these more common instruments do not have such romantic appeal as do aircraft and other special instruments, industry depends none the less upon their accuracy and performance to maintain plant equipment at peak efficiency.

When you need electric instruments for any purpose, may we help you? General Electric, Schenectady, N. Y.

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